



Spring MSG005 at Ballard Mine

P4 PRODUCTION

2009 GROUNDWATER MONITORING SAMPLING AND ANALYSIS PLAN

**FINAL
Revision 3**

Prepared by

P₄ Production, LLC



MWH

2353 130th Avenue N.E., Suite 200
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August 2009



August 10, 2009

Mr. Mike Rowe
IDEQ
444 Hospital Way, #300
Pocatello, ID 83201

**RE: 2009 Groundwater Monitoring Sampling and Analysis Plan
Final – Revision 3**

Dear Mike,

Please find enclosed the final 2009 Groundwater Monitoring Sampling and Analysis Plan, which is being submitted on behalf of P4 Production (P4). This final version incorporates comments listed in the approval letter provided by the Agencies and Tribes on 3 August 2009.

As always, if you have any questions please do not hesitate to contact Barry Koch at (208) 547-1439 or myself at (970) 879-6260.

Best Regards,

A handwritten signature in black ink, appearing to read "Cary Foulk".

Cary L. Foulk
Supervising Geologist/Geochemist

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**Response to 3 August 2009 Agencies and Tribes Comments on the 2009
Groundwater Water Monitoring Sampling and Analysis Plan, Revision 2, 24 July 2009**

General Comments

None

Specific Comments

2-1. Table 2-1, page 2-5, Step 4, Temporal boundary. When explaining the decision factors for sampling in the fall, it might make sense, and would be more consistent, to use the new language found in Section 3.3.3, paragraph 1 on page 3-13.

Response: *Text has been revised to be consistent with the language found in section 3.3.3.*

Appendices

Field Sampling Plan

2-2. Table 4-1. Add other parameters to be analyzed such as gross alpha and gross beta, hardness, and total suspended solids.

Response: *Table has been revised to include all containers and parameters.*

Editorial Comments

Section 2.0, page 2-1, paragraph 3, line 3. Change *principle* to “principal.”

Table 2-1, page 2-5, Step 3, bullet 7. It appears that this bullet would be improved by insertion of a comma(s), such as “existing site characterization, groundwater quality sampling and analysis plans and procedures”.

Table 2-1, page 2-6, Step 4, Practical Constraints. Delete the comma and insert a closing parenthesis after *MDS034*.

Table 2-1, page 2-6, Step 5, Principal Study Question #3, line 2. Insert a comma for the last *and* to read “. . . groundwater and surface water, aid in review . . .”

Table 2-1, page 2-7, Step 7, line 2. Change *is* to “are.”

Section 3.3.2, page 3-11, bullet 5 (Dump seeps, springs, and streams), line 6. Change *bee* to “be.”

Section 3.3.3, page 3-13, paragraph 3 (last), line 4. Add a period after criteria and capitalize *these* to read “. . . groundwater quality criteria. These locations . . .”

Appendices

Field Sampling Plan

Table 4-3, page 4-8, column 2. Add “MWs” after *2008* to read “2008 MWs & MMW009”.

Table 4-5, pages 4-12 and 4-13. Change the title of the table to “. . . and 2009 Monitoring Wells”.

Table 4-5, page 4-12, column 6. To be consistent with Table 3-3 in the SAP and Table 4-3 in the FSP, add “Cr” in the column beginning *Total Cd*.

Table 4-5, page 4-12, column 7. To be consistent with Table 3-3 in the SAP and Table 4-3 in the FSP, add “Fe” in the column beginning *Total Al*.

Table 4-7, page 4-17, column 10. To be consistent with Table 3-3 in the SAP and Table 4-3 in the FSP, delete *K* and *Na* in the column beginning *Dissolved Ca*.

Response: *The editorial revisions have been made.*

**2009 GROUNDWATER MONITORING
SAMPLING AND ANALYSIS PLAN**

**FINAL
Revision 3**

AUGUST 10, 2009

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ACRONYMS AND ABBREVIATIONS

A/T	Agencies and Tribes
Al	Aluminum
Ca	Calcium
CaCO ₃	Calcium carbonate
Cd	Cadmium
Cl	Chloride
COPC	Contaminant of Potential Concern

Cr	Chromium
DQOs	Data Quality Objectives
e.g.	<i>exempli gratia</i> (Latin, for example)
EE/CA	Engineering Evaluation/Cost Analysis
Fe	Iron
FOE	Factor of Exceedance
FSP	Field Sampling Plan
HSP	Health and Safety Plan
IDEQ	Idaho Department of Environmental Quality
i.e.	<i>id est</i> (Latin, that is to say; in other words)
K	Potassium
MCL	Maximum Contaminant Level
mg/L	Milligrams per Liter
Mg	Magnesium
Mn	Manganese
MWH	MWH, Inc. (formerly Montgomery Watson Harza, Inc.)
Na	Sodium
Ni	Nickel
P4	P4 Production, L.L.C.
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RA	Risk Assessment
RI/FS	Remedial Investigation/Feasibility Study
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
Se	Selenium
SI	Site Investigation
SO ₄	Sulfate
SOP	Standard Operating Procedure
V	Vanadium
Zn	Zinc

This document was prepared collaboratively between P4 Production and MWH. It presents the relevant component documents for a Sampling and Analysis Plan (SAP) for the 2009 groundwater monitoring program at the P4 Production, L.L.C. (P4) mines near Soda Springs, Idaho. The mines include the properties of Ballard, Henry, and Enoch Valley mines, collectively referred to as the Sites. This sampling and analysis plan is being submitted as a deliverable under the Consent Order/Administrative Order of Consent for the Performance of Site Investigations and Engineering Evaluations/Cost Analysis (EE/CAs) at P4 Production, L.L.C. Phosphate Mine Sites in Southeastern Idaho (08/20/03), EPA Docket No. CERCLA-10-2003-0117.

Characterization of groundwater at the Sites has been conducted in a phased approach since 2004. The *Draft 2007 and 2008 Data Summary Report* (MWH, 2009a) provides a summary of the most recent groundwater characterization results. As noted in this document, ongoing monitoring of Contaminants of Potential Concern (COPC) concentrations and piezometric conditions in monitoring wells and specific seeps and springs is needed to complete characterization of the nature and extent of COPCs in groundwater. The groundwater data collected under this plan will also support the evaluation of surface water/groundwater interaction and refinement of the hydrogeologic conceptual models of the Sites.

The components of this SAP include the field sampling plan (FSP), quality assurance project plan (QAPP), and health and safety plan (HSP). The FSP is included in Appendix A. The QAPP and HSP, which are not modified, are included by reference as *QAPP Addendum* (MWH, 2009d) and *Health and Safety Plan* (MWH, 2009c), respectively. In addition, as it is a key part of the project planning process, the data quality objectives (DQOs) are presented in this document in Section 2.0.

While the SAP and FSP components are prepared as complete documents, it needs to be recognized that this continued groundwater monitoring is part of the overall characterization of the P4 Sites. Therefore the larger work plan and SAP components are not repeated herein (i.e., an abbreviated SAP is presented). For complete background on the overall characterization of the Sites the following overall work plan documents should be referenced:

- *Comprehensive Site Investigation, Enoch Valley (Henry or Ballard) Mine Work Plan—Final* (MWH, 2004a)
- *Comprehensive Site Investigation, Enoch Valley (Henry or Ballard) Mine Project Field Sampling Plan—Final* (MWH, 2004b)
- *Comprehensive Site Investigation, Enoch Valley (Henry or Ballard) Mine Program Field Sampling Plan—Final* (MWH, 2004c)
- *Comprehensive Site Investigation, Enoch Valley (Henry or Ballard) Mine Quality Assurance Plan—Final* (MWH, 2004d)

- *Comprehensive Site Investigation, Enoch Valley (Henry or Ballard) Mine Health and Safety Plan—Final* (MWH, 2004d)
- *Quality Assurance Project Plan Addendum Program Quality Assurance Plan – Final* (MWH, 2009d) (*QAPP Addendum*)

2.0 DATA QUALITY OBJECTIVES

The DQOs discussed in this section were used to guide the development of the sampling program. They identify the objectives and quality of data that must be obtained to perform continued groundwater characterization and monitoring to support the decision making process related to the current engineering evaluation/cost analysis (EE/CA) program. (Work is currently underway to transition this program to a remedial investigation/feasibility study (RI/FS) program.)

The DQOs are consistent with EPA guidance (USEPA, 2006) and apply the following seven-step process:

1. State the problem
2. Identify the goals of the study
3. Identify information inputs
4. Define the boundaries of the study
5. Develop the analytic approach
6. Specify performance or acceptance criteria
7. Develop the plan for obtaining data

DQOs have been specifically developed to guide the screening and selection of the groundwater monitoring stations and analytes, which are the most substantial modifications to the groundwater program. Within these, the principal study question (from Step 2) has a corresponding statement, as appropriate, in each of the remaining DQO steps. Outputs are given in each step and follow the 2006 DQO guidance (USEPA, 2006).

Each step of the DQO Process defines criteria that will be used to establish the final data collection design. The first five steps are primarily focused on identifying qualitative criteria, such as:

- the nature of the problem that has initiated the study and a conceptual model of the environmental hazard to be investigated;
- the decisions or estimates that need to be made and the order of priority for resolving them;
- the type of data needed; and
- an analytic approach or decision rule that defines the logic for how the data will be used to draw conclusions from the study findings (USEPA, 2006).

The sixth step establishes acceptable quantitative criteria on the quality and quantity of the data to be collected, relative to the ultimate use of the data. For this groundwater monitoring program, the

data are primarily collected for the measurement of analyte levels in groundwater to characterize potential contamination and potential risk to human health and ecological receptors, and as such, the uncertainty in the data will be estimated and evaluated once collected. Current EPA-approved methods will be used for estimation of the level of uncertainty associated with the data.

In the seventh step of the DQO Process, a data collection design is developed that will generate data meeting the quantitative and qualitative criteria specified at the end of Step 6. The output from this step is largely contained in the FSP.

Two key factors that need to be considered in the DQO process are the conceptual model, for helping formulate the problem statements (DQO Step 1), and in this case, the facility map for identifying the spatial bounds of the program. The conceptual model is presented here to support the DQOs detailed in Table 2-1, *Groundwater Monitoring DQOs*. The facility map is included in the FSP.

The primary components of the conceptual model that support the DQOs are summarized as follows for groundwater:

- Source – COPCs present in interburden and overburden rocks deposited in waste rock dumps, but possibly present in mine pits and other facilities, that are able to enter groundwater systems due to seepage and/or runoff and infiltration.
- Release mechanisms – Exposure to air and water results in mobilization of COPCs from increased surface area; precipitation may leach and mobilize COPCs primarily during spring runoff to receiving groundwater.
- Exposure pathways – Primary exposure through ingestion of COPCs in surface expressions of groundwater or direct ingestion from water supply wells.
- Receptors – Livestock, wildlife, or human ingestion of surface expressions of groundwater or water supply wells with elevated COPCs.

These conceptual model components will be re-evaluated, refined, and verified as the project moves into risk assessment.

TABLE 2-1
GROUNDWATER MONITORING DATA QUALITY OBJECTIVES

<p align="center">Step 1 - State the Problem</p>	<p>Historical mining operations at P4's Sites have resulted in mine waste materials being potential sources of selenium and other constituents to the environment. In general, the predominant mobilization mechanism for COPCs from these potential source areas occur during the spring runoff via surface water and shallow groundwater transport of dissolved constituents. However, deeper infiltration to intermediate or regional groundwater systems is also possible. Groundwater characterization has been conducted in a phased approach. Continued investigation and monitoring is needed to assist in determination of the nature and extent of selenium and other COPC impacts in groundwater. In addition, the groundwater monitoring provides beneficial information regarding groundwater/surface water interaction, which will assist in refinement of the hydrogeologic conceptual models of the Sites for the identification of potential removal or remedial actions.</p> <p>The primary components of the conceptual model that support the DQOs are summarized as follows for groundwater:</p> <ul style="list-style-type: none"> • Source – COPCs present in interburden and overburden rocks deposited in waste rock dumps, but possibly present in mine pits and other facilities, that is able to enter groundwater systems due to seepage and/or runoff and infiltration. • Release mechanisms – Exposure to air and water results in mobilization of COPCs from increased surface area; precipitation may leach and mobilize COPCs primarily during spring runoff to receiving groundwater. • Exposure pathways – Primary exposure through ingestion of COPCs in surface expressions of groundwater or direct ingestion from water supply wells. • Receptors – Livestock, wildlife, or human ingestion of surface expressions of groundwater or water supply wells with elevated COPCs. <p>The planning team, decision makers, and principal data users include P4 and the A/T.</p>
<p align="center">Step 2 – Identify the Goals of the Study</p>	<p>Principal Study Question #1 Are COPCs in groundwater monitoring wells and surface expressions of groundwater that assist in groundwater characterization elevated above the appropriate screening levels¹ that may pose risks to human health and ecological receptors?</p> <p>Alternative actions:</p> <ol style="list-style-type: none"> 1. Evaluate the need to sample additional downgradient wells or conduct additional characterization. 2. No Action. No further characterization is required and the data will be forwarded to the site investigation (SI) and risk assessment (RA). <p>Decision statement: The decision is to determine whether the groundwater COPC concentrations are</p>

¹ Table 3-1, *Achievable Laboratory Limits and Applicable Project Screening Values Groundwater Parameters*, contains the applicable risk-based screening levels.

**TABLE 2-1
GROUNDWATER MONITORING DATA QUALITY OBJECTIVES**

elevated above the groundwater standard (e.g., 0.05 mg/L for selenium) that may pose risks to human health or ecological receptors and if groundwater is contributing to surface water bodies such that the surface water quality standards are being exceeded. If monitoring wells are found to be equal to or exceed the groundwater standard or surface expressions of groundwater are found to be equal to or exceed the surface water quality standard, then additional downgradient wells need to be sampled. If the downgradient wells at the edge of a plume are equal to or exceed the standards, then the need for additional characterization in that area will be evaluated. If increasing trends are observed temporally, the need for additional monitoring or characterization will also be evaluated. All data will be evaluated in the site investigation (SI) and risk assessment (RA). If monitoring well concentrations are less than the groundwater standards or less than the surface water quality standard for surface expressions of groundwater, then no further characterization is required and the data will be forwarded to the SI and RA.

Principal Study Question #2

Are surface expressions of groundwater (seeps, springs, and headwaters) associated with potential P4 sources being adequately monitored (spatially and temporally) by the surface and groundwater monitoring station network in order to constrain the hydrogeologic conceptual model and the nature and extent of contamination?

Alternative actions:

1. Evaluation indicates that the surface expressions of groundwater can be optimized and the number of stations and/or analytes adjusted for future monitoring. Data will be forwarded to the SI and RA.
2. No Action. Station data and analyte list are of adequate quality, quantity, and in proper locations to constrain the conceptual model and nature and extent of contamination. Data will be forwarded to the SI and RA.

Decision statement:

Determine whether seep, spring, and headwater monitoring stations and analytes assist in defining the hydrogeologic conceptual model and nature and extent of contamination. If not, modify the number, analyte list, and/or locations of the monitoring stations sampled; otherwise, the existing stations and analyte list will continue to be sampled.

Principal Study Question #3

Are temporal changes in groundwater associated with changes in surface water quality and vice versa?

Alternative actions:

1. Monitor the temporal changes in surface water and alluvial groundwater during similar times of the year as specified in the *2009 and 2010 Surface Water Monitoring Sampling and Analysis Plan* (MWH, 2009c) and this Groundwater Monitoring Sampling and Analysis Plan. Evaluation indicates that the monitoring network can be optimized and the number of stations and/or analytes adjusted for future interim monitoring. Data will be forwarded to the SI and RA.
2. No Action. Station data and analyte lists are of adequate quality, quantity, and in proper locations to determine the relationship (if any) between temporal changes in groundwater and surface water quality. Data will be forwarded to the SI and RA.

Decision statement:

Determine what effect temporal changes in groundwater quality have on surface water

**TABLE 2-1
GROUNDWATER MONITORING DATA QUALITY OBJECTIVES**

	<p>quality, and vice versa in order to evaluate the potential interconnection between the two systems to aid in review of fate and transport of COPCs and evaluation of removal or remedial actions. Modify the number, analyte list, and/or locations of the monitoring stations sampled in order to determine the potential effect these changes may have on each system; otherwise, the existing stations and analyte list will continue to be sampled.</p>
<p>Step 3 – Identify Information Inputs</p>	<p>The information inputs for the decision process include the following items that may exist or will need to be created.</p> <ul style="list-style-type: none"> • list of analytes • current conceptual site models • existing facilities investigation information to be updated as needed (inventory and spatial delineation of potential source areas) • sample location maps (contained in FSP) • historic surface water and groundwater data (use of existing data will be dependent upon evaluations of data usability); data will be analyzed with appropriate methods for determining inorganic concentrations with detection limits suitable for comparison to risk-based screening levels • hydrogeologic information such as flow directions, flow rates, and distance of wells to seeps and springs • existing site characterization, groundwater quality sampling and analysis plans and procedures • risk-based screening benchmarks for analytes
<p>Step 4 – Define the Boundaries of the Study</p>	<p>Population of Interest: Metals/metalloids and general groundwater quality parameters.</p> <p>Spatial boundaries: Groundwater monitoring locations, including surface expressions of groundwater, characterizing impacted groundwater at Ballard, Henry, and Enoch Valley mine areas.</p> <p>Vertical boundary: Screened depth of groundwater monitoring well and practical depth of monitoring well installation.</p> <p>Temporal boundary: The temporal boundary for groundwater monitoring at all proposed stations is spring 2009 during peak flow (i.e., peak potential loading). This is due to the nature of contaminant transport positively correlating with spring runoff and the potential hydraulic connections between the shallow alluvial system and surface water. Sites for fall sampling were retained based on the following: (1) higher selenium or sulfate</p>

**TABLE 2-1
GROUNDWATER MONITORING DATA QUALITY OBJECTIVES**

	<p>concentrations in the fall compared to the spring, (2) selenium or sulfate concentrations greater than the applicable groundwater quality standard, (3) lack of historical fall sample data, and (4) increasing concentrations trends. Additional wells installed in fall 2009 will be monitored following development.</p> <p>Scale of Decision Making: Spatially-relevant groundwater monitoring locations from each sampling event.</p> <p>Practical Constraints Sampling to occur during peak flow in spring. Some proposed sample locations (e.g., MDS025 and MDS034) may be dry in the fall.</p>
Step 5 – Develop the Analytic Approach	<p>Principal Study Question #1 The relevant compliance threshold linked to protection of human health is 0.05 mg Se/L in groundwater. The relevant compliance threshold linked to protection of ecological health is 0.005 mg Se/L in surface water. If monitoring location selenium concentrations are equal to or exceeds these standards then further downgradient boundary monitoring will be evaluated, otherwise the selenium plume is considered bounded by the existing monitoring locations. Other COPCs will be evaluated, but for groundwater at P4's sites, selenium has been found to be the best indicator of impacts associated with mine waste areas.</p> <p>Principal Study Question #2 If a monitoring station and/or analyte are not required to evaluate potential impacts to surface expressions of groundwater sites (dump seeps and springs) from potential upgradient P4 sources, then the need for the monitoring points and/or analytical parameters will be evaluated. For example, some stations may be redundant. If the proposed monitoring stations and/or analytes are not sufficient to constrain the hydrogeological conceptual model, evaluate temporal trends, and constrain the nature and extent of contamination, then the need for additional monitoring points and/or analytical parameters will be evaluated. Otherwise the proposed locations and analytes will be considered adequate for the intended purpose of defining the conceptual model.</p> <p>Principal Study Question #3 If a monitoring station and/or analyte are not required to evaluate potential relationships and temporal trends between groundwater and surface water, aid in review of the fate and transport of COPCs and evaluation of removal or remedial actions, then the need for the monitoring points and/or analytical parameters will be evaluated. If the proposed monitoring stations and/or analytes are not sufficient to evaluate the relationship between groundwater and surface water, then the need for additional monitoring points and/or analytical parameters will be evaluated. Otherwise the proposed locations and analytes will be considered adequate for the intended purpose of evaluating the relationship between surface water and alluvial groundwater and assisting in evaluation of fate and transport of COPCs.</p>
Step 6 – Specify Performance or Acceptance Criteria	<p>A groundwater monitoring location that assists in characterization of the groundwater system will be retained.</p> <p>A surface expression of groundwater station (seeps, springs, and streams) located downstream of a potential P4 source area solely characterizing potential P4 surface</p>

TABLE 2-1 GROUNDWATER MONITORING DATA QUALITY OBJECTIVES	
Step 6 – Specify Performance or Acceptance Criteria	<p>A groundwater monitoring location that assists in characterization of the groundwater system will be retained.</p> <p>A surface expression of groundwater station (seeps, springs, and streams) located downstream of a potential P4 source area solely characterizing potential P4 surface water quality impacts will be retained for ongoing characterization and effectiveness monitoring.</p> <p>Best professional judgment will be used to evaluate the hydrogeologic factors associated with the monitoring stations, and how these factors may be relevant to the need for ongoing monitoring.</p> <p>Analytical parameters will be compared to the applicable groundwater quality risk-based screening level².</p> <p>The precision, accuracy, representativeness, comparability, and completeness criteria and the minimum detection limits will be used to evaluate the usability of analytical data in making decisions about characterization of groundwater and at a minimum will help ensure that data collected for the interim monitoring will be of comparable quality when compared to the 2004-2008 site characterization data.</p> <p>Measurement errors will be minimized by implementing standard operating procedures for the sample collection, handling, preparation and analysis methods.</p> <p>All data must meet approved usability as defined in the <i>QAPP Addendum</i> (MWH, 2009b).</p>
Step 7 – Develop the Plan for Obtaining Data	<p>The existing groundwater data were reviewed as part of the preparation of this SAP. The sampling rationale and design based on existing data are presented in Section 3.0 of this SAP. The sampling design included screening of existing spatially-relevant surface expressions of groundwater locations as well as evaluation of analytes that exceed applicable groundwater quality risk-based standards. The sampling design will be further evaluated if groundwater monitoring suggests that the proposed locations and analytes are not sufficient to assist in groundwater characterization. The field methods and quality assurance requirements are presented in the FSP located in Appendix A.</p>

²Table 3-1, *Achievable Laboratory Limits and Applicable Project Screening Values Groundwater Parameters*, contains the applicable risk-based screening levels.

3.0 GROUNDWATER LOCATION AND ANALYTICAL RATIONALE

A purpose of this plan is to identify a network of groundwater monitoring locations for the characterization of nature and extent of constituents in groundwater and to identify an applicable analyte list.

P4 anticipates installing additional monitoring wells in fall 2009, as part of the continued groundwater characterization to address identified data gaps. The locations and number of those wells are generally known. The analyte list for these new locations is discussed in Section 3.3. P4 anticipates finalizing these additional characterization activities during calendar year 2009 with A/T input and approval. For the existing monitoring and borehole wells (pre-pack wells installed during the 2008 Direct Push Program), seeps, and springs, it is proposed that all the proposed locations are sampled in spring 2009 following surface water sampling and a specific subset of the proposed locations will be sampled in fall 2009. Monitoring wells installed in fall 2009 will be sampled post-development during the same period.

Unvalidated, censored groundwater quality data were evaluated from previous investigations. All values below the reporting limit were reported as surrogates at that reporting limit. The summarized results of this evaluation are presented in Sections 3.2 and 3.3, as well as an analyte list for future monitoring at existing and proposed groundwater points.

3.1 SPATIAL/CATEGORICAL RELEVANCE

P4 evaluated five types of groundwater monitoring locations— monitoring wells, borehole monitoring wells, production/domestic/agricultural wells, dump seeps, springs, and streams. The categories were evaluated for spatial adequacy to characterize groundwater, as well as the amount of available data collected from 2004 onward. Surface expressions of groundwater (headwater stream locations) were also evaluated for future performance monitoring in the *2009 and 2010 Surface Water Monitoring Sampling and Analysis Plan* (MWH, 2009b).

The spatial/categorical relevance of groundwater monitoring locations was evaluated. The purpose of this evaluation was to determine if various groundwater features, in close proximity, had similar chemical results. If groundwater points were in close proximity and chemically similar, then logically, one location could be used as a surrogate point to characterize changes to groundwater as part of characterization and any future performance monitoring. An example of this evaluation can be seen at Ballard Mine. Dump seeps MDS030—MDS033 are all in close proximity to each other along the western edge of MWD093, above the MMP035 high wall. The proximity evaluation was limited to dump seeps and springs.

Monitoring wells or production/domestic/agricultural wells were excluded from this spatial evaluation. P4 will continue to sample groundwater quality at all monitoring wells (MMW---) for the 2009 field season to add to the existing groundwater quality data, and because a number of these wells have been installed only in the last two years. Production/domestic/agricultural wells will not be sampled as discussed in Section 3.3 below.

Existing dumps seeps, and springs are suitable for monitoring groundwater quality at Ballard, Henry, and Enoch Valley mines based on their location. The supporting rationale for retaining or rejecting sampling points at Henry and Enoch Valley mines is driven chiefly by the existing water quality results, presented in Section 3.2. At Ballard Mine, P4 believes that the four seeps MDS030—MDS033 characterize the same groundwater unit due to their close proximity to one another, and all being situated along the western edge of the Ballard mine pit #2 overburden dump (MWD093) above the Pit #1 (MMP035) high wall. As such, P4 will sample only one of these dump seeps going forward, as the water chemistry at these four dump seeps is similar, and P4 has a sampling record at these four locations since spring 2004 (seven sampling events—four spring and three fall).

3.2 CHEMICAL QUALITY/ANALYTICAL SCREENING

The second part of the evaluation screened total fractions in past water quality data against the current list of approved groundwater analytes from IDEQ (IDEQ, 2008). Both IDEQ and USEPA groundwater screening benchmarks are for total chemical fractions.

The current list of approved analytes is (IDEQ, 2008):

- [Filtered] aluminum (Al), cadmium (Cd), calcium (Ca), chloride (Cl), chromium (Cr), iron (Fe), magnesium (Mg), manganese (Mn), nickel (Ni), potassium (K), selenium (Se), sodium (Na), sulfate (SO₄), total alkalinity (Alk), vanadium (V), zinc (Zn).
- [Unfiltered] aluminum (Al), cadmium (Cd), chromium (Cr), iron (Fe), manganese (Mn), nickel (Ni), selenium (Se), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), vanadium (V), zinc (Zn).

MW009 required an expanded analyte list, in addition to the above analyte list:

- [Filtered] arsenic (As), barium (Ba), boron (B), lead (Pb), molybdenum (Mo), thallium (Tl), uranium (U).
- [Unfiltered] arsenic (As), barium (Ba), boron (B), lead (Pb), molybdenum (Mo), thallium (Tl), uranium (U).

3.2.1 Screening Criteria

Table 3-1, *Achievable Laboratory Limits and Applicable Project Screening Values Groundwater Parameters*, presents the available screening criteria that were compiled for this analytical screening phase. This table also shows the highlighted screening value chosen for screening groundwater data. The applicable screening values were evaluated for each of the groundwater analytes. The evaluations of screening values considered first the use of an applicable promulgated state standard and second the use of a conservative groundwater screening value. The selected standards considered for screening analytes is presented below.

- 1) IDAPA 58.01.11 Ground Water Quality Rule Primary and Secondary Constituents Standards. Cadmium, unspeciated chromium, and selenium were evaluated under the primary constituent standards. Aluminum, chloride, iron, manganese, sulfate, total dissolved solids, and zinc were evaluated against the secondary constituent standards.
- 2) IDEQ Risk Management Plan Monitoring Action Level Groundwater Trending and Release Detection. Nickel and vanadium were evaluated under these advisory levels. The risk management plan advisory levels are based on the Clean Water Act/Water Quality Standard Criteria (nickel) and Tier II Secondary Chronic Benchmarks (vanadium).
- 3) USEPA National Primary Drinking Water Standards Maximum Contaminant Levels. Uranium was evaluated using this benchmark.
- 4) USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites (RSLs) (USEPA, 2008). Aluminum, iron, manganese, uranium, and zinc were evaluated secondarily under these tap water screening benchmarks. These chemicals were evaluated under a second tier for limited exceedances observed for secondary groundwater criteria, since Idaho secondary groundwater criteria are not health based.

Dissolved fractions were not evaluated in the water quality evaluation. Personal communications with IDEQ (Ed Hagan) and USEPA (Safe Drinking Water Hotline, 800-426-4791) indicate that screening benchmarks are only relevant for total chemical fractions. IDEQ indicated that when one has total chemical fractions, one must use those for evaluating water quality. In order to use dissolved fractions in conjunction with, or in lieu of, total fractions, one must provide rationale and obtain special permission from IDEQ to do so. The results of the screening are presented in Table 3-2, *Summary of Total Metal Fractions Maximum Factors of Exceedance in Groundwater*. Within this table are the maximum factors of exceedance for those groundwater monitoring points where water quality benchmarks are exceeded. MMW009 groundwater quality data were included in this data set.

Water quality data from MMW009 were screened against the same criteria as above and included an expanded analyte list. A change in the screening was the use of USEPA maximum contaminant levels (MCL) against uranium concentrations, as this MCL is more conservative than USEPA RSLs. Dissolved fractions were not evaluated for MMW009 as outlined in the preceding paragraph.

Exceedances (and maximum factors of exceedance [FOE]) for MMW009 were the following:

- aluminum (12.2)—No exceedances if evaluated against USEPA RSLs.
- beryllium (2.5)
- cobalt (4.5)
- iron (7.3) —No exceedances if evaluated against USEPA RSLs.
- lead (1.9)
- manganese (3.7) —No exceedances if evaluated against USEPA RSLs.

Although analyte screening was evaluated, it will not be utilized for MMW009. P4 proposes to sample MMW009 for the same expanded analytical suite used for 2008 and 2009 monitoring wells as discussed in Section 3.3.

TABLE 3-1

**ACHIEVABLE LABORATORY LIMITS AND APPLICABLE PROJECT SCREENING VALUES
GROUNDWATER PARAMETERS
(Page 1 of 1)**

Method	Monitoring Parameter ¹	Units	Achievable Laboratory Limits ²		Applicable Screening Levels								Health Comparison Values of Drinking Water ⁹	
					State of Idaho Standard	IDEQ Area Wide RMP ⁴		EPA MCL ⁷		EPA ⁸				
			Ground Water ³	Groundwater Levels		Regional SL ⁸	Tap Water							
				Removal ⁵				Monitoring ⁶	Primary	Secondary				
EPA 6020A	Cadmium	mg/L	0.0005	0.000125	0.005	0.005	0.0010	0.005	--	--	0.018	--	--	
	Chromium (total)	mg/L	0.002	0.0005	0.1	0.1	0.0250	0.1	--	--	55 ^a	0.1	0.1	
	Manganese	mg/L	0.002	0.0005	(0.05)	--	--	--	--	--	0.88	--	--	
	Nickel	mg/L	0.004	0.001	--	0.73	0.160	--	--	--	0.73	--	--	
	Selenium	mg/L	0.001	0.0005	0.05	0.050	0.0050	0.05	--	--	0.18	--	--	
	Uranium	mg/L	0.040	0.010	--	--	--	0.03 ^b	--	--	0.11	0.03 ^b	0.03 ^b	
	Zinc	mg/L	0.025	0.005	(5)	5.0	0.100	--	--	--	11	--	--	
	Aluminum	mg/L	0.1	0.05	(0.2)	--	--	--	--	--	37	--	--	
EPA 6010B	Calcium	mg/L	0.2	0.1	--	--	--	--	--	--	--	--	--	
	Iron	mg/L	0.1	0.025	(0.3)	--	--	--	--	--	26	--	--	
	Magnesium	mg/L	0.5	0.25	--	--	--	--	--	--	--	--	--	
	Potassium	mg/L	1	0.25	--	--	--	--	--	--	--	--	--	
	Sodium	mg/L	0.5	0.25	--	--	--	--	--	--	--	--	--	
	Vanadium	mg/L	0.01	0.005	--	0.26	0.020	--	--	--	0.26	--	--	
	Chloride	mg/L	0.2	0.1	(250)	--	--	--	--	--	--	--	--	
	Sulfate	mg/L	1	0.5	(250)	--	--	--	--	--	--	--	--	
SM2340B	Hardness	mg/L	5	5	--	--	--	--	--	--	--	--		
EPA 310.2	Alkalinity, total	mg/L	10	5	--	--	--	--	--	--	--	--		
EPA 160.1	TDS	mg/L	10	5	(500)	--	--	--	500	--	--	--		
EPA 160.2	TSS	mg/L	5	2.5	--	--	--	--	--	--	--	--		

Primary source for screening

Secondary choice for screening

No available screening benchmark

¹ The project- or event-specific target parameter list will be established prior to the sampling event; samples may or may not be analyzed for all listed parameters.

² Generally achievable laboratory reporting limits; method detection limits will vary annually and by laboratory.

³ State of Idaho Ground Water Quality Rule (IDAPA 58.01.11); secondary standard in parentheses.

⁴ Removal action and monitoring levels; Area Wide Risk Management Plan (RMP; IDEQ 2004).

⁵ Values are "total recoverable" (unfiltered).

⁶ Values are unfiltered.

⁷ EPA primary and secondary Maximum Contaminant Level (MCL), National Primary Drinking Water Regulations, EPA (<http://www.epa.gov/safewater/contaminants/index.html#rads>, 17 March 2008).

⁸ EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm, 12 September 2008).

⁹ Public Health Assessment: Southeast Idaho Phosphate Mining Resource Area: Bannock, Bear Lake, Bingham, and Caribou Counties, Idaho EPA Facility ID: IDN001002245 (U.S. Department of Health and Human Services, Public Health Services, Agency for Toxic Substances and Disease Registry, 2006).

^a Value is for chromium III.

^b Reporting limit is greater than screening value, but MDL is less than the screening value.

CWA - Clean Water Act

IDAPA Idaho Administrative Protection Agency

IDEQ - Idaho Department of Environmental Quality

mg/L - milligrams per liter

na - not applicable to this method

pCi/L - picocuries per liter

TDS - total dissolved solids

TSS - total suspended solids

MWH

2009 GROUNDWATER MONITORING

SAP

AUGUST 2009

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TABLE 3-2
SUMMARY OF TOTAL METAL FRACTIONS
MAXIMUM FACTORS OF EXCEEDANCE IN GROUNDWATER

Station	Mines, Aquifer	Al ²	Cl	Cd	Cr	Fe ²	Mn ²	Ni	Se	SO4	TDS	U ²	V	Zn
MDS016	H					NS	NS			1.5	1.5	NS		
MDS022	H	5.6				4.9	12.3				1.2			
MDS025	E					NS	NS		34.8	3.4		NS	5.3	
MDS026	E			8.0		1.1	19.3(1.1)		8.6	3.4	3.1	1.5	2.5	
MDS030	B	9.9				5.4	2.1		18.4		1.2			
MDS031	B	5.1				1.6			15.4		1.4			
MDS032	B	13.5				7.6			29.2	2.6	2.4			
MDS033	B	10.1				6.4	1.2		44.0	3.0	2.9			
MDS034	H					2.7	1.6		2.8		1.1			
MMW004 ¹	H, A			100.0	5.0	3.6	60.0	18.8			1.0		50.0	123.4
MMW006	B, R								1.6					
MMW007	E, A	2.4				1.2	12.2							
MMW008	E, A	43.8				23.2	9.1							
MMW009	E, R	12.2				7.3	3.7							
MMW010	H, A			1.1		1.2	67.8(3.9)		2.0	2.2	2.5			
MMW011	H, R	1.2				1.4	1.5							
MMW013	E, I						3.0		1.8	1.3	1.3			
MMW014	H, A					2.3	18.9(1.1)				1.2			
MMW017	B, A	1.1					9.6		2.6	1.8	2.1			
MMW018	B, A						1.4							
MMW019	H, I										1.1			
MMW020	B, R	1.2		2.2		3.7	1.6				1.0		1.9	
MMW021	B, R						3.4							
MMW022	H, I	1.6					2.1			1.1	1.3			
MMW023	H, R					16.6	18.7(1.1)	1.1			1.5			
MMW024 ³	E, I	1.8				1.1					1.0	NS		
MMW025 ³	E, I	6.9				3.4	1.4					NS		
MMW026 ³	E, R											NS		
MMW027 ³	E, I								6.3		1.4	NS		
MMW028 ³	H, I											NS		
MMW029 ³	B, I								16.1	2.2	2.7	NS		
MMW030 ³	B, W						1.7					NS		
MMW031 ³	B, W											NS		
MPW006	E, R/I	NS		NS	NS	NS	NS	NS	NS		NS	NS	NS	NS
MPW019	E, ?					5.6	1.0							
MPW020	E, R/I	NS		NS	NS	NS	NS	NS	NS		NS	NS	NS	NS
MPW022 ¹	H, I			100.0	5.0	26.9	60.0	18.8					50.0	109.4
MPW023	H, I					1.0	4.1							
MSG001	E													
MSG002	H	4.7				2.5	2.3					NS		
MSG003	B								12.8		1.3			
MSG004	B	21.1				4.5	8.3		1.0					
MSG005	B						2.1						2.5	
MSG006	B	4.4				2.8	8.3		5.6	2.4	1.5			
MSG007	B	21.9				14.1	6.0			7.2	1.1			
MSG008	B	1.3			2.7			1.1	6.8	1.8	1.8			
MST096	B	9.5				4.8	1.1		1.0					
MST136	E	1.4												

TABLE 3-2
SUMMARY OF TOTAL METAL FRACTIONS
MAXIMUM FACTORS OF EXCEEDANCE IN GROUNDWATER

MST144	E		1.0	NS	NS	4.6	1.8	NS	
--------	---	--	-----	----	----	-----	-----	----	--

Notes:

1) Unusually high reporting limits in fall 2005 for MMW004 or MPW022 only. These two locations were re-evaluated with fall 2005 results removed from the data pool. No exceedance observed in MMW004, or MPW022 if shaded green. Or, the new maximum factor of exceedance is shown parenthetically. Fall 2005 analytical results for Cd, Cr, Mn, Ni, V, and Zn showed high reporting limits due to sample dilution in the analytical method (the reporting limits is typically adjusted upward by the factor of dilution). Zn concentrations in fall 2005 were 3—5 orders of magnitude higher than any subsequent monitoring.

2) Al, Fe, Mn, and U were secondarily evaluated against USEPA RSLs because the primary screening values (IDAPA 58.01.11) are secondary standards based on aesthetics. For these four chemicals, blue shading indicates that no exceedance was observed when compared against the USEPA RSL benchmarks. New maximum factors of exceedance are shown parenthetically, where appropriate.

3) Monitoring well installed in 2008.

"NS" and gray shading indicate no analytical data for that location. If a cell is blank with no shading, a sample was collected and the maximum factor of exceedance is < 1. For MPW006 and MPW020, dissolved fractions were collected for many analytes, including Se, which are not relevant for comparing to IDEQ/USEPA screening benchmarks.

A = Alluvial – may include colluvium, weathered Dinwoody Formation or basalt

I = Intermediate – typically Dinwoody Formation, but may include Thaynes or Phosphoria Formations

R = Regional – Wells Formation

H = Henry Mine

B = Ballard Mine

E = Enoch Valley Mine

The results presented in this table show the majority of exceedances are found for selenium, sulfate, and TDS. To a lesser extent, exceedances also occur for cadmium and vanadium. It must be noted that agricultural, domestic, and borehole wells were not included in the analytical screening. Domestic and agricultural wells are not included in the 2009 sampling program. In addition, all borehole monitoring wells are being sampled and were not screened spatially or analytically as discussed in Section 3.3.

3.3 LOCATION/ ANALYTE SELECTION

3.3.1 Location Selection

Based on the results of the screening, P4 recommends retaining or excluding the following locations, by category:

Monitoring Wells: P4 will sample all MMW--- locations in 2009. Additional wells installed in fall 2009 will also be included for monitoring. Wells that have been replaced by new monitoring wells (e.g., MMW001) will be excluded. In addition, wells MW-15A and MW-16A will also be sampled at the Ballard Mine as they are located within plumes on the west side of the mine. These two wells

were installed for the Blackfoot Bridge Environmental Impact Study baseline data collection program but will now be incorporated into the 2009 groundwater monitoring program for the SI.

Production Wells: P4 will exclude production wells from any future monitoring programs. The results in Table 3-2 from the groundwater quality evaluation show no selenium or other chemical exceedances in these production wells (the initial maximum factors of exceedance shown in Table 3-2 are attributable to unusually high fall 2005 reporting limits or for iron or manganese secondary criteria exceedances under IDAPA 58.01.11). Additionally, P4 has a record of several sampling efforts for these locations. In addition, given uncertainty regarding the construction of these wells and hydrogeologic units screened, it is not advisable to rely on these wells for characterization. However, it has been prudent to sample these locations as potential locations for direct exposure to the COPCs.

Agricultural and Domestic Wells: For reasons similar to the production wells, agricultural and domestic wells (MAW and MDW) will not be sampled.

Dump seeps: P4 will continue to monitor dump seeps MDS025, -026, -030, and -034. Dump seeps MDS016 and MDS022 at Henry Mine will be excluded due to limited and low maximum factors of exceedance for SO_4 and TDS, as well as limited exceedances of Al, Fe, and Mn in MDS022 against IDAPA secondary standards. Dump seeps MDS025 and MDS026 at Enoch Valley Mine, show exceedances of selenium and other analytes. Additionally, MDS030 will be used as a surrogate for MDS031—033, as outlined in Section 3.1 above. P4 will continue to monitor MDS034 due to limited water quality data at this location.

Springs: P4 will continue to monitor MSG004—007. MSG001—003 will be excluded from future monitoring because P4 has a record of several sampling events for these locations. MSG001 and MSG002 have shown no selenium exceedances. P4 has monitored MSG003 seven times to date. MSG008, Hayfield Pipe, will not be monitored in 2009 because P4 believes this water to be from the same source as MST069, Short Creek, which is scheduled for continued monitoring under this groundwater plan and under the surface water monitoring program as described in the *2009 and 2010 Surface Water Monitoring Sampling and Analysis Plan* (MWH, 2009b). MSG008 also empties into the Short Creek channel, south of the haul road.

Streams (surface expressions of groundwater): P4 will continue to monitor MST096 at Ballard mine as this location represents the easternmost monitoring point for the southeast plume at MWD082. In addition, location MST136 and MST144 at Enoch Valley will also be monitored to evaluate potential impacts from MWD092.

Borehole Monitoring Wells: This is an additional groundwater monitoring category for 2009 to include the existing borehole monitoring wells (pre-pack wells) installed during the 2008 direct push

groundwater investigation. Those pre-pack wells that are currently in place will be monitored during the 2009 groundwater investigation. At Ballard Mine, MBW006, -009, -011, -026, -027, -028, -032, -048 will be monitored. At Enoch Valley Mine, MBW085, -087, -099, -107, -112 will be monitored. No direct push pre-pack wells are installed at Henry Mine. Pre-pack wells will also be installed during the 2009 direct push continuation effort. Details can be found in the *Direct Push Groundwater Continuation Sampling and Analysis Plan* (P4, 2009).

3.3.2 Analyte Selection

The analyte selection below presents the proposed analyte list for 2009 groundwater monitoring in Table 3-3, *2009 Groundwater Proposed Analyte List*. Based on IDEQ and USEPA guidance, P4 recommends that only unfiltered or total fractions be analyzed for metals. While dissolved metal fractions have been measured in the past and are more useful for geochemical evaluations, they are not directly comparable to applicable IDEQ and USEPA screening benchmarks for groundwater. At this time P4 believes that sufficient dissolved fraction metals data from a sufficient number of wells is available to make geochemical interpretations.

Direct push borehole wells installed in 2008 will not be filtered for metals. However, if a borehole well cannot be effectively developed in accordance with standard procedures specified in the FSP, resulting in highly turbid water samples, the samples will be filtered.

The recent direction given by IDEQ related to the analytical parameters for groundwater (e-mail, 28 April 2009 at 12:15) was the following:

"We would remind you that new wells drilled in 2008 need to be sampled for the expanded list of analytes. Also, 2008 pre-packs will need to be sampled for the "regular" list of analytes, including major ions for water-typing. We realize that samples from the pre-packs will be analyzed for dissolved fractions only."

Based on this direction, the proposed analytes for the 2009 groundwater monitoring are listed in Table 3-3. Further discussion of the analyte list, by groundwater monitoring location type is given below. In addition to the recommended analytes, P4 will also take physical water quality parameters, described in greater detail in the FSP in Appendix A.

**TABLE 3-3
2009 GROUNDWATER PROPOSED ANALYTE LIST**

Category	Fraction	Analytes (Analytical Method)
2008 monitoring wells and MMW009	Unfiltered Unfiltered Unfiltered Unfiltered Unfiltered Unfiltered Filtered Filtered Filtered Filtered Filtered	TDS (EPA 160.1) TSS (EPA 160.2) Al, Ba, Be, Fe, Mo, V (EPA 6010B) Sb, As, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, Ag, Tl, U, Zn (EPA 6020A) Hg (EPA 7471) Gross alpha, gross beta (EPA 900) Nitrogen - total nitrate-nitrite (EPA 353.2) SO ₄ , Cl (EPA 300.0) Ca, Fe, Mg, K, Na (EPA 6010B) Alkalinity (EPA 310.2) Hardness (SM2340B)
Direct push borehole wells and 2009 monitoring wells	Unfiltered Unfiltered Unfiltered Unfiltered Unfiltered Filtered Filtered Filtered Filtered Filtered	TDS (EPA 160.1) TSS (EPA 160.2) Al, Fe, V (EPA 6010B) Cd, Cr, Mn, Ni, Se, Zn (EPA 6020A) Gross alpha, gross beta (EPA 900) Nitrogen - total nitrate-nitrite (EPA 353.2) SO ₄ , Cl (EPA 300.0) Ca, Fe, Mg, K, Na (EPA 6010B) Alkalinity (EPA 310.2) Hardness (SM2340B)
2007 & older monitoring wells	Unfiltered Filtered Unfiltered	Se (EPA 6020A) SO ₄ (EPA 300.0) TDS (EPA 160.1)
Seeps, springs, and streams	Unfiltered Unfiltered Unfiltered Filtered Filtered Filtered	TDS (EPA 160.1) Cd, Se (EPA 6020A) V (EPA 6010B) Cd (EPA 6020A) Ca, Mg (EPA 6010B) SO ₄ , Cl (EPA 300.0)
Notes: Major ions are Ca, Fe, Mg, K, and Na Hardness is calculated on filtered fractions of Ca and Mg		

2008 monitoring wells and MMW009

- Expanded analyte list (see Table 3-3). The expanded analyte list as presented in Table B-3 from Appendix B, *2008 Phase IIb Monitoring Well Installation Technical Memorandum - Final*, dated April 2008 (MWH, 2008) with the exception of orthophosphate and ferrous/ferric iron. A copy of this table is included below.

Direct push borehole wells and 2009 monitoring wells

- Regular analyte list (see Table 3-3). The regular analyte list is the non-asterisked analytes presented in Table B-3 from Appendix B, *2008 Phase IIb Monitoring Well Installation Technical Memorandum - Final*, dated April 2008 (MWH, 2008) with the exception of orthophosphate and ferrous/ferric iron. However, chromium will also be included in the analyte list for these borehole wells. In addition, as noted above, metals analysis will be analyzed from the unfiltered, total fraction, unless excessive turbidity is encountered in the well.

2007 & older monitoring wells

- The results of the screening presented above in Table 3-2 for pre-2008 monitoring wells show exceedances for Cd, Ni, Se, SO₄, TDS, and V when evaluated against primary and secondary screening benchmarks. Due to low numbers of exceedances in Cd, Ni, and V, as well as low factors of exceedance, P4 proposes to drop these analytes from the analytical suite (see Table 3-3). In addition, major ions are not included in the analytical suite since data has been collected for geochemical typing of these wells.

Production, Agricultural, and Domestic Wells

- None

Dump seeps, springs, and streams

- The seep, spring, and stream analytes are selected based on the results in Table 3-2. Only five analytes showed any exceedances after primary and secondary screening. Total and dissolved fractions at seeps, springs, and streams will be analyzed because these locations can also be evaluated as surface water (see Table 3-3). Stream stations MST144 and MST069 will be sampled under both the groundwater and surface water program. This will require that the stations be sampled for slightly different suites and different fractions of analytes as required by both programs.

From Appendix B, 2008 Phase IIb Monitoring Well Installation Technical Memorandum – Final:

Table B-3 2008 Groundwater Analytes for Existing Wells				
Parameter	Method	EDL	Reporting Units	Holding Time (days)
alkalinity, total	SM2320B	2	mg/L	14
aluminum	M200.7 ICP	0.03	mg/L	180
antimony*	M200.8 ICP/MS	0.0004	mg/L	180
Arsenic*	M200.8 ICP/MS	0.0001	mg/L	180
Barium*	M200.7 ICP	0.0001	mg/L	180
beryllium*	M200.7 ICP	0.0001	mg/L	180
cadmium	M200.8 ICP/MS	0.0001	mg/L	180
calcium	M200.7 ICP	0.2	mg/L	180
chloride	M300.0	0.5	mg/L	28
chromium*	M200.8 ICP/MS	0.0001	mg/L	180
cobalt*	M200.7 ICP	0.01	mg/L	180
copper*	M200.7 ICP	0.01	mg/L	180
gross alpha	M900.0	2	pCi/L	180
gross beta	M900.0	4	pCi/L	180
hardness	Calculation	1.5	mg/L	-
iron	M200.7 ICP	0.01	mg/L	180
ferrous iron, dissolved (Field)	HACH	0.01	mg/L	-
ferric iron, dissolved	Calculation	0.01	mg/L	-
lead*	M200.8 ICP/MS	0.0001	mg/L	180
manganese	M200.8 ICP/MS	0.0005	mg/L	180
magnesium	M200.7 ICP	0.2	mg/L	180
mercury*	M245.1	0.0002	mg/L	28
molybdenum*	M200.7 ICP	0.01	mg/L	180
nickel	M200.8 ICP/MS	0.0006	mg/L	180
Nitrogen (total nitrate-nitrite)	M 353.2	0.02	mg/L	28
orthophosphate	M 365.1	0.005	mg/L	28
pH	M150.1	0.1	pH	-
potassium	M200.7 ICP	0.3	mg/L	180
selenium	SM3114 B, AA-Hydride	0.001	mg/L	180
silver*	M200.7 ICP	0.01	mg/L	180
sodium	M200.7 ICP	0.3	mg/L	180
sulfate	M300.0	0.5	mg/L	28
thallium*	M200.8 ICP/MS	0.0001	mg/L	180
total dissolved solids+	M160.1	10	mg/L	7
total suspended solids+	M160.1	10	mg/L	7
uranium*	M200.8 ICP/MS	0.0001	mg/L	180
vanadium	M200.8 ICP/MS	0.0002	mg/L	180
zinc	M200.8 ICP/MS	0.002	mg/L	180
<p>* -- Analytes to be analyzed only in groundwater collected from monitoring wells MMW007, MMW009, MMW010, MMW012, MMW014, MMW017, and MMW018, and surface water at sites not previously sampled for the expanded list of analytes.</p> <p>+ -- Analyte to be analyzed only in groundwater collected from monitoring well MMW009 and 5% of these monitoring wells: MMW001, MMW004, MMW009, MMW011, MMW013, MMW014, MMW017, MMW019, MMW020, and MMW022.</p> <p>bicarbonate and carbonate to be analyzed only in groundwater collected from monitoring wells used for geochemical typing.</p> <p>Methods are for media (non-blank) samples.</p> <p>Equipment and field blanks will be analyzed for unfiltered results. For regulatory compliance, all media samples will be analyzed for unfiltered metals.</p> <p>EDL – Estimated Detection Limit; the laboratory analytical limit does not reflect possible sample-specific elevation of the reporting limit due to dilution, contamination or other issues identified during the data validation process.</p>				

3.3.3 Seasonal Sampling Evaluation

Based on A/T direction, P4 evaluated the spring and fall selenium and sulfate data collected in 2004, 2007, and 2008 at the spatially relevant locations. These data are presented below in Table 3-4, *Summary of Selenium and Sulfate Concentrations and Seasonal Sampling Evaluation*. This evaluation supported the decision to sample some stations in the fall as well as the spring. Sites for fall sampling were retained based on the following: (1) higher selenium or sulfate concentrations in the fall compared to the spring, (2) selenium or sulfate concentrations greater than the applicable groundwater quality standard, (3) lack of historical fall sample data, and (4) increasing concentrations trends. The following locations will be sampled in fall 2009 based on the rationale provided below:

1) Historic samples results are higher in the fall than the spring and exceed either the selenium or sulfate water quality criteria:

- MDS026
- MDS030
- MMW010
- MMW013
- MST069

2) Fall samples results have never been collected and available spring data samples exceed the selenium or sulfate water quality criteria:

- MDS025
- MDS034
- MST144

3) Historic samples results are higher in the fall than the spring but are below either the selenium or sulfate water quality criteria:

- MSG004

In addition, MST069 will be sampled under both the surface water and groundwater monitoring programs.

It is also noted that if the pending spring 2009 data is significantly lower than the fall 2008 data for wells installed in 2008, then additional wells (e.g., MWM027 and MWM029) will be included in the fall sampling program. In addition, future evaluations will consider whether wells or other groundwater sampling locations exceed the groundwater quality criteria. These locations may also be included in future fall sampling events.

**TABLE 3-4
SUMMARY OF SELENIUM AND SULFATE CONCENTRATIONS
AND SEASONAL SAMPLING EVALUATION**

Location	Spring 2004		Fall 2004		Spring 2007		Fall 2007		Spring 2008		Fall 2008	
	Se	SO ₄	Se	SO ₄	Se	SO ₄	Se	SO ₄	Se	SO ₄	Se	SO ₄
	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
MDS025	0.016	590			0.056	838						
MDS026	0.43	810	0.006	3	0.157	786	0.019	850	0.19	582	0.0190	733
MDS030	0.52	144	0.57	15.3	0.73	164	0.92	91	0.45	129	0.893	172
MDS034									0.14	183		
MMW001		99.6		100			0.028	117				
MMW002		53.6		49.3								
MMW003		81.3		123								
MMW004		137		137			0.002	129	0.002	125	0.0025	116
MMW006							0.08	60.7	0.069	59.1	0.0733	58.4
MMW007							0.002	21	0.005	8.8	0.0024	55.1
MMW008							0.005	9.2	0.005	35.9	0.0014	29.6
MMW009							0.001	87.7	0.005	62.8	0.0012	55.8
MMW010							0.005	36.7	0.1	367	0.0182	547
MMW011							0.005	98.4	0.005	96.1	0.0009	89
MMW013							0.005	274	0.051	332	0.0909	273
MMW014							0.005	35.8	0.005	61.9	0.0020	36.9
MMW017							0.13	461	0.103	452	0.101	447
MMW018							0.03	48.6	0.027	60.4	0.0274	50.2
MMW019							0.005	159	0.004	93.5	0.0006	159
MMW020							0.017	127	0.01	131	0.0088	113
MMW021							0.047	50	0.049	44.6	0.0495	45.2
MMW022							0.018	245	0.017	263	0.0175	239
MMW023							0.003	211	0.004	222	0.0039	214
MMW024											0.0139	192
MMW025											0.0009	9.66
MMW026											0.0013	19.5
MMW027											0.314	229
MMW028											0.0026	68

**TABLE 3-4
SUMMARY OF SELENIUM AND SULFATE CONCENTRATIONS
AND SEASONAL SAMPLING EVALUATION**

Location	Spring 2004		Fall 2004		Spring 2007		Fall 2007		Spring 2008		Fall 2008	
	Se	SO ₄	Se	SO ₄	Se	SO ₄	Se	SO ₄	Se	SO ₄	Se	SO ₄
	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
MMW029											0.806	547
MMW030											0.0010	15
MMW031											0.0009	3.21
MSG004	0.016	33.5	0.031	46	0.015	29.1			0.005	26.6	0.0135	37.2
MSG005	0.007	34.4	0.004	30	0.007	35.9	0.002	23.3	0.015	33.8	0.0050	30.1
MSG006	0.22	390	0.28	438	0.26	602	0.018	215	0.098	354	0.0234	299
MSG007					0.003	62.4	0.003	1810	0.02	63.1	0.0131	72.1
MST069					1.1	1290	0.034	1340	0.87	990	1.2	1200
MST096	0.02	100	0.027	59.4					0.031	96.1	0.0302	92.5
MST136	0.016	143							0.021	40.5		
MST144	0.229	340							0.21	196		
Notes:												
Units in mg/L												
Station will be sampled in the spring and fall 2009.												
Station will be considered for sampling in fall 2009 based on spring 2009 results (i.e., if spring results are lower than fall results)												

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APPENDICES

APPENDIX A – FIELD SAMPLING PLAN

**2009 GROUNDWATER MONITORING
FIELD SAMPLING PLAN**

**FINAL
Revision 3**

August 10, 2009

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ATTACHMENTS

Attachment 1	Standard Operating Procedures
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ACRONYMS AND ABBREVIATIONS

A/T	Agencies and Tribes
BW	Borehole Monitoring Well
DQOs	Data Quality Objectives
e.g.	<i>exempli gratia</i> (Latin, for example)
FSP	Field Sampling Plan
FTU	Formzin Turbidity Unit
HSP	Health and Safety Plan
IDEQ	Idaho Department of Environmental Quality
i.e.	<i>id est</i> (Latin, that is to say; in other words)
HDPE	high-density polyethylene
mg/L	Milligrams per Liter
MWH	MWH, Inc. (formerly Montgomery Watson Harza, Inc.)
P4	P4 Production, L.L.C.
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
SAP	Sampling and Analysis Plan
SEGW	Surface Expression of Groundwater
SOP	Standard Operating Procedure
SW	Surface Water

1.0 INTRODUCTION

This Field Sampling Plan (FSP) details the work scope for groundwater monitoring at existing groundwater stations around P4's Ballard, Henry, and Enoch Valley Mines. Groundwater stations include monitoring wells, direct push pre-pack wells, and surface expressions of groundwater (SEGW) such as springs and seeps. Direct push program borehole monitoring wells (BW's), to be installed in 2009, will be sampled concurrently with this effort, but the reader is directed to the *Direct Push Groundwater Continuation Sampling and Analysis Plan* (P4, 2009) for program and sampling details. This FSP is an attachment to the *2009 Groundwater Monitoring Sampling and Analysis Plan* (SAP). The SAP presents the Data Quality Objectives (DQOs) that have been developed to guide the monitoring program presented in this FSP. The complementary documents to the FSP are the *Quality Assurance Project Plan (QAPP) Addendum* (MWH, 2009b) and *Health and Safety Plan* (HSP). The QAPP and HSP are included by reference and this FSP is included as Appendix A of the SAP, respectively.

The FSP is organized as follows:

Section 1 – Introduction

Section 2 – Program Background and Objectives: provides a brief summary of information related to the need for continued groundwater monitoring, and information on the available historic data as well as the sampling objectives and design rationale

Section 3 – Sample Locations, Frequency, and Schedule: specifies the field sampling and analysis activities

Section 4 – Sample Collection and Analysis: summarizes protocols for all sample collection and handling procedures and sample analyses and laboratory methods

Section 5 – Project Organization: presents the project team, schedule, and deliverables

Section 6 – References

2.0 PROGRAM BACKGROUND AND OBJECTIVES

This section provides brief background information related to groundwater monitoring for the Ballard, Henry, and Enoch Valley Mines. Additional program background details may be obtained from the *2004 Site Investigation Work Plans* (MWH, 2004), the *Draft 2007 and 2008 Data Summary Report Mines Site Investigation* (MWH, 2009a), and the *Conditional Final - 2007 Hydrogeologic Data Collection Activities and Updated Conceptual Models - Interim Report for Hydrogeologic Investigation* (MWH, 2008).

Characterization of groundwater at the Sites has been ongoing since 2004. The *Draft 2007 and 2008 Data Summary Report* (MWH, 2009a) provides a summary of the most recent groundwater characterization results. As noted in the SAP, ongoing monitoring of COPC concentrations and piezometric conditions in monitoring wells and specific seeps and springs is needed to complete characterization of the nature and extent of selenium in groundwater. The groundwater data collected under this plan will also support the evaluation of surface water/groundwater interaction and refinement of the hydrogeologic conceptual models of the Sites. Sampling stations, analytical parameters, and monitoring frequency have been reevaluated to ensure that they are complementary to the aforementioned objectives. This rationale as well as the screening and evaluation are documented in Section 3.0 of the SAP.

3.0 SAMPLE LOCATIONS, FREQUENCY, AND SCHEDULE

This section describes the groundwater monitoring program sampling locations and frequencies. The sampling locations and frequencies are summarized programmatically below in Table 3-1, *Groundwater Sampling Locations, Frequency, and Schedule*. The locations of the sampling stations are shown in Drawing 3-1, *Groundwater Sampling Locations*. These sampling locations were screened according to the rationale in Section 3.0 of the SAP.

TABLE 3-1 GROUNDWATER MONITORING LOCATIONS, FREQUENCY, AND SCHEDULE							
Mine	Station Description	Location		Station Number	Station Type	2009	
		Latitude	Longitude			Spring	Fall
Ballard	Short Creek	42 49 04.15	111 29 25.80	MBW006	BW	x	
	Blackfoot River Road @ Monsanto Haul Road	42 49 12.96	111 29 48.71	MBW009	BW	x	
	Ballard Creek	42 49 23.46	111 29 38.93	MBW011	BW	x	
	Ballard, Western Shallow	42 50 01.91	111 29 54.83	MBW026	BW	x	
	Ballard, Western Deeper	42 50 02.23	111 29 54.34	MBW027	BW	x	
	Torgeson	42 49 34.44	111 29 42.93	MBW028	BW	x	
	Holmgren	42 49 33.92	111 28 11.14	MBW032	BW	x	
	Wooley Valley Creek	42 50 03.76	111 27 56.21	MBW048	BW	x	
	Ballard Mine, Pit #2 Upper Dump Seep	42 49 43.00	111 29 22.00	MDS030	DS	x	x
	South of West Ballard Pit; south of waste rock dumps	42 49 20.0	111 29 03.0	MMW006	MW	x	
	Northwest of Ballard Mine into Long Valley Creek alluvial flow field	42 49 59.6	111 29 47.4	MMW017	MW	x	
	East of Ballard Mine in Wooley Valley alluvial flow field	42 49 39.4	111 28 04.5	MMW018	MW	x	
	East side of West Ballard Pit (MMP035); replacement of MMW001	42 49 36.4	111 29 03.3	MMW020	MW	x	
	West side of West Ballard Pit (MMP035); replacement of MMW002	42 49 35.6	111 29 23.9	MMW021	MW	x	
	East Ballard mine area in the vicinity of MMW018	42 49 37.78	111 28 08.74	MMW029	MW	x	
	Along the southwestern portion of Ballard Mine in the vicinity of MMW016A	42 49 10.72	111 29 17.03	MMW030	MW	x	
	Along the western perimeter of Ballard Mine in the vicinity and north of MMW017	42 50 11.87	111 29 43.05	MMW031	MW	x	
	Adjacent to MWD084	TBD	TBD	MMW032	MW		x
	Deeper well nested with MMW029	TBD	TBD	MMW033	MW		x
	West Ballard Mine near MST068	42 49 35.99	111 29 36.55	MW-15A	MW	x	
	Southwest Ballard Mine near MST069	42 49 08.83	111 29 16.53	MW-16A	MW	x	
	Ballard Mine, Holmgren Spring	42 49.3063	111 28.0794	MSG004	SG	x	x
	Ballard Mine, Cattle Spring	42 49.3277	111 28.0855	MSG005	SG	x	
	Ballard Mine, Southeast Spring	42 49 42.60	111 27 59.00	MSG006	SG	x	
	Ballard Mine, South of Southeast Spring	42 49 63.05	111 27 86.16	MSG007	SG	x	
	Short Creek below Ballard Mine	42 49 11.23	111 29 19.75	MST069	ST	x	x
	Tributary of North Fork Wooley Valley Creek, below Ballard Mine	42 49 30.00	111 27 45.00	MST096	ST	x	

TABLE 3-1 GROUNDWATER MONITORING LOCATIONS, FREQUENCY, AND SCHEDULE							
Mine	Station Description	Location		Station Number	Station Type	2009	
		Latitude	Longitude			Spring	Fall
Henry	Henry Mine, Dump Seep #3 (new for 2008)	42 53 46.82	111 29.10.25	MDS034	DS	x	✗
	North of Henry Mine north pit	42 54 07.7	111 29 46.5	MMW004	MW	x	
	Southeast of Center Henry Pit; near MPW023	42 52 22.3	111 27 51.3	MMW010	MW	x	✗
	Northwest of Center Henry Pit; south of Little Blackfoot River	42 53 48.3	111 29 30.0	MMW011	MW	x	
	Southeast of Henry Mine center pit in Lone Pine Creek alluvial flow field	42 51 59.3	111 27 05.2	MMW014	MW	x	
	North of Henry Mine center pit	42 53 50.2	111 29 25.4	MMW019	MW	x	
	Northeast lobe of Henry Mine waste rock dump MWD086	42 53 09.2	111 28 18.3	MMW022	MW	x	
	Henry Mine North Pit	42 54 20.50	111 30 27.50	MMW023	MW	x	
	Near the Little Blackfoot River northwest of MMW019	42 53 50.24	111 28 60.00	MMW028	MW	x	
Enoch Valley	Rasmussen Creek	42 51 55.52	111 24 04.12	MBW085	BW	x	
	Rasmussen Road and Agrium Haul Road intersection	42 51 38.34	111 23 44.32	MBW087	BW	x	
	Agrium Haul Road North	42 51 57.08	111 23 28.14	MBW099	BW	x	
	Western Enoch Valley, East of fence	42 53 28.32	111 25 55.86	MBW107	BW	x	
	Western Enoch Valley, West of fence	42 53 34.67	111 26 13.72	MBW112	BW	x	
	Enoch Valley Mine, West Dump Seep	42 52 12.50	111 24 11.50	MDS025	DS	x	✗
	Enoch Valley Mine, South Dump Seep	42 51 48.70	111 23 35.70	MDS026	DS	x	✗
	South of EVM South Dump; near edge of dump footprint	42 51 48.5	111 23 34.4	MMW007	MW	x	
	South of EVM South Dump; south and downgradient of MMW007	42 51 48.6	111 23 29.8	MMW008	MW	x	
	Central North Dump (MWD091)	42 53 34.6	111 25 33.8	MMW009	MW	x	
	Northwest of EVM North Dump in Lone Pine Creek alluvial flow field	42 53 28.75	111 25 53.34	MMW012	MW	x	
	Southwest of EVM in Rasmussen Creek alluvial flow field	42 52 05.7	111 24 12.0	MMW013	MW	x	✗
	Along the south end of Enoch Valley Mine, near MMW013	42 52 11.73	111 24 11.86	MMW024	MW	x	
	Along the south end of Enoch Valley Mine, near MMW007	42 51 49.16	111 23 31.95	MMW025	MW	x	
	Northeast of MPW006/MMW008	42 51 56.48	111 23 25.75	MMW026	MW	x	
	Near MMW012	42 53 28.97	111 25 53.50	MMW027	MW	x	
	Deeper well nested with MMW013	TBD	TBD	MMW034	MW		x
	Deeper well nested with MMW027	TBD	TBD	MMW035	MW		x
	Well west of MMW027	TBD	TBD	MMW036	MW		x

TABLE 3-1 GROUNDWATER MONITORING LOCATIONS, FREQUENCY, AND SCHEDULE							
Mine	Station Description	Location		Station Number	Station Type	2009	
		Latitude	Longitude			Spring	Fall
	Rasmussen Creek headwaters near Enoch Valley Mine Shop Pond	42 52 34.00	111 25 03.00	MST136	ST	x	
	West Pond Creek headwaters, below West Pond	42 52 16.07	111 24 18.67	MST144	ST	x	x
Notes: Location (GPS) coordinates use the NAD27 datum and are presented in ddd mm ss.ss format (degrees minutes seconds). TBD - To be determined DS - Dump Seep BW - Borehole Monitoring Well SG - Spring MW - Monitoring Well ST - Stream							

4.0 SAMPLE COLLECTION AND ANALYSIS

This section presents the site access requirements, equipment, and procedures for the collection, handling, and analysis of each surface water sample. Where applicable, references to SOPs in Attachment 1 are provided.

4.1 SITE ACCESS, LOGISTICS, AND SAFETY

P4 has access to all groundwater monitoring locations. The A/T will be notified, at minimum, five business days prior to commencement of field activities. The MWH Field Team Leader will notify the P4 Project Manager (Barry Koch) at minimum three days prior to working at a mine area. Such notification is necessary to allow time for site-specific safety training by P4, and if necessary, to arrange for a P4 representative to accompany the crew to provide access through locked gates. Relevant P4, agency, and other field contacts are provided in Section 5.0.

Field equipment and samples will be stored at the Fox Hills Ranch, owned by P4. Equipment, supplies, and samples will be shipped and received from the Monsanto plant, in Soda Springs, in care of Barry Koch, P4. Additional sample handling and shipping information is presented in Section 4.6.

Safety procedures for the site investigation are described in the HSP. Parts of the Enoch Valley Mine area are still active, and thus, Enoch Valley has its own safety requirements that will be followed by field personnel when working in, or traveling through, active areas of the Site. The mine-specific safety requirements involve a short training orientation for hazard recognition and avoidance provided by P4. In the event that any of P4's safety policies are stricter than the requirements of the HSP, those safety requirements will take precedence. Sampling teams will make every effort to sample locations in active areas of the mine outside of normal Monsanto operating hours (i.e., on Fridays, Saturdays, or Sundays).

4.2 GROUNDWATER COLLECTION

4.2.1 Surface Expressions of Groundwater (SEGW)

SEGW samples will be collected using the protocols outlined in SOP-NW-9.1, *Collection of Surface Water Samples*. This SOP is located in Attachment 1.

Surface water samples would normally be taken from streams using a Kemmerer horizontal water bottle sampler, either across the channel, or along the channel, as permitted. However SEGW samples are usually collected from stations at small streams, seeps, and springs and will be taken using a suitable polyethylene container, i.e., the 1-Liter bottle from the swing sampler or a suitable pitcher. Water samples will be transferred to appropriate sample containers after collection and any required filtering.

Unfiltered, acidified samples will, as needed, be collected and analyzed for total metals. Filtered, acidified samples will, as needed, be collected and analyzed for “dissolved” metals. Filtered samples will be filtered in the field using a new 0.45-micron disposable filter at each sample location. Filtered and unfiltered, unacidified samples will also be collected for major ions and alkalinity. Parameters to be analyzed for are described in Section 4.9. Refer to Table 4-1, *Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times* for analyte sample container requirements. Water samples will be collected upon arrival at the station, prior to field water quality and flow measurements, to ensure high-quality, undisturbed samples.

For sample documentation, digital photos must be taken at each sampling location. A minimum of two photos should be taken at each location, one facing downstream, and one facing upstream, as appropriate.

4.2.2 Monitoring Wells

Monitoring well samples will be collected using the protocols outlined in SOP-NW-5.3, *Collection of Groundwater Quality Samples* and the SOP *Low Stress Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells*. These SOPs are located in Attachment 1.

Upon arrival at a well, measurement of the static water level is required. Measurement of the static water level is performed using a electronic water level indicator. The same measuring point on the casing is used to ensure the measurements are consistent. For MWH field studies, the wellhead reference point will be at the top of casing (PVC) - north side. See SOP-5, *Groundwater Level Data Collection*, for more information.

Low-stress sampling techniques, in accordance with EPA protocol, will be used for sampling wells when possible. Low-stress sampling may not be possible in existing wells if dedicated, high-flow pumps are already installed, or if the required sampling equipment cannot access the well. Detailed sampling protocol is included in the SOP. The sampling protocol states requirements for water level stabilization and parameter stabilization. Bladder pumps for low-stress sampling will be set at least 20 feet (if possible) below the air-water interface in the well, and pumped through dedicated tubing to the surface. The wells will be purged in accordance with USEPA protocols, such that water from the formation will be transported from the aquifer to the surface with minimal agitation.

In the event that the well produces water at an extremely slow rate and excessive drawdown is occurring (> 0.30 feet), even at a pumping rate of 100 mL/min, then a “purge and sample” method shall be employed. Under these circumstances, wells must be purged dry one time and allowed to recharge to a minimum of 80% of the original water level, and then the sample will be drawn. Monitoring wells MMW007, MMW010, MMW025, and MMW030 may need this method used.

Unfiltered, acidified samples will, as needed, be collected and analyzed for total metals. Filtered, acidified samples will, as needed, be collected and analyzed for “dissolved” metals. Filtered samples will be filtered in the field using a new 0.45-micron disposable filter at each sample location. Filtered and unfiltered, unacidified samples will also be collected for major ions and alkalinity. Parameters to be analyzed for are described in Section 4.9. Refer to Table 4-1, *Requirements for Containers, Preservation*

Techniques, Sample Volumes, and Holding Times for analyte sample container requirements. Contrary to SW and SEGW station protocol, monitoring well samples will be collected last; after water level and parameter stabilization has occurred.

**TABLE 4-1
REQUIREMENTS FOR CONTAINERS, PRESERVATION TECHNIQUES, SAMPLE VOLUMES , AND HOLDING TIMES**

Sample Container— Water Matrices	Preservative	Parameter*	Analytical Method	Sample Preparation Method	Maximum Holding Time (Days)
250 mL HDPE	HNO ₃ pH < 2	dissolved metals (field filtered)	EPA 6010B and 6020A	microwave-assisted acid digestion (3015 ICP-MS) or hot plate acid digestion (3005A ICP)	180
250 mL HDPE	HNO ₃ pH < 2	total metals (unfiltered)	EPA 6010B and 6020A	microwave-assisted acid digestion (3015 ICP-MS) or hot plate acid digestion (3005A ICP)	180
250 mL HDPE	HNO ₃ pH < 2	hardness (dissolved)	SM 2340	calculated by the laboratory from dissolved calcium and manganese ICP metals results**	180
250 mL HDPE	≤ 6 °C	dissolved chloride and sulfate (field filtered)	300.0	none (direct analysis on ion chromatograph)	28
500 mL HDPE	≤ 6 °C	alkalinity (unfiltered)	310.2	none (direct analysis colorimeter)	14
250 mL HDPE	≤ 6 °C	total dissolved solids (unfiltered)	160.1	desiccation	7
250 mL HDPE	HNO ₃ pH < 2	total suspended solids (unfiltered)	160.2	desiccation	7
250 mL HDPE	H ₂ SO ₄ pH <2	dissolved nitrogen (total nitrate-nitrite) (field filtered)	353.2	none (direct analysis colorimeter)	28
2000 mL HDPE	HNO ₃ pH < 2	gross alpha/beta (unfiltered)	900.0	desiccation	180

Notes:

*Refer to Table 4-3, *Groundwater Analytes*, for groundwater parameters and methods.

** Per SM2340B, hardness (mg equivalent CaCO₃/L = 2.497 [Ca, mg/L] + 4.118 [Mg, mg/L]; concentrations for dissolved Ca and Mg determined by ICP.

HDPE – high-density polyethylene

4.3 FIELD PARAMETER MEASUREMENTS

SEGW field parameter measurements will be made in-situ whenever possible after the collection of the sample. If an in-situ measurement is not possible, then the measurement will be made streamside from a suitable container.

Monitoring well parameter measurements will be made using a flow-through cell, and readings will be recorded after parameter stabilization has occurred. Refer to the *Low Stress Purging* SOP for stabilization requirements.

Field parameter values will be recorded on field data forms and in field notebooks. The following field water quality parameters will be measured:

- pH
- Conductivity
- Specific conductivity
- Temperature
- Dissolved oxygen
- Turbidity
- Oxidation-reduction potential

Field meters will be used in accordance with the manufacturer's instructions and calibration performed in accordance with Table 4-2, *Calibration and Maintenance Requirements for Field Equipment*. Conductivity, dissolved oxygen, turbidity, and pH meter performance will be calibrated each morning prior to field sampling and checked for accuracy before each station throughout the day. At the quality assurance/quality control (QA/QC) monitoring stations, all measurements will be taken three times.

TABLE 4-2 CALIBRATION AND MAINTENANCE REQUIREMENTS FOR FIELD EQUIPMENT*			
Field Parameter	Required Procedure	Minimum Frequency	Required Equipment or Calibration Fluids
pH	2-point calibration	Each day prior to sampling	One pH buffer (7 pH), Reference Standard
Temperature	N/A	N/A	N/A
Dissolved Oxygen	Atmospheric calibration	Each day prior to sampling	Atmospheric oxygen with elevation
Conductivity	1-point reference	Each day prior to sampling	Reference Standard
ORP	1-point reference	Each day prior to sampling	Reference Standard
Turbidity	1-point calibration	Each day prior to sampling	Reference Standard
Flow	Velocity equivalence and spin test (Price meters) or equivalent	When the rotor is changed	Stopwatch, measuring tape
Notes: *In the event of a discrepancy, the manufacturer's instruction manual shall take precedence.			

4.4 SEGW FLOW MEASUREMENTS

Surface water flow rate measurements or estimates, if applicable, will be made from all SEGW monitoring locations listed programmatically in Table 3-1 of this FSP in conjunction with the collection of the water quality sample. Flow measurements will always be recorded after the SEGW water quality sample and field parameters have been collected to prevent potential contamination. Flow measurements will typically be measured with current meters using the velocity-area method (Rantz, 1982). For streams less than 0.2 feet deep, flow will be measured using a volumetric method, if possible. Details of surface water flow measurement methods are presented in SOP-NW-9.2a, *Surface Water Flow Measurements Using Man-Portable Devices or Estimation Techniques*, which is located in Attachment 1.

4.5 WATER LEVEL DATA LOGGER RETRIEVAL

A Solinst Levellogger® data logger was installed in each well in the fall of 2008. The data loggers are recording water level, temperature, and time once each day. Field teams will download the data logger readings in spring and fall of 2009. Hydrographs of the readings will be provided in future reports.

4.6 BOREHOLE MONITORING WELL DEVELOPMENT

Borehole monitoring wells (BW stations) installed during the 2008 Direct Push program must be developed and must be done so before BW sampling can commence. For those BW stations that have not been developed, this effort will be conducted during this GW sampling event.

Development protocol and details can be found in the *Direct Push Groundwater Continuation Sampling and Analysis Plan* (P4, 2009).

At BWs, constituents will be analyzed for the total fraction. However, if development is not successful, and turbidity fails to get below 5 Formazin Turbidity Unit (ftu), BW samples will be field filtered and the dissolved fraction will be reported.

4.7 SAMPLE DESIGNATION

Samples will be labeled with all necessary information on laboratory supplied labels using waterproof ink. At a minimum, each sample label shall contain the following information:

- Station identification
- Sample identification
- Date and time of sample collection, with sampler's initials
- Analyses required
- Filtered or unfiltered
- Method of preservation, if used
- Sample matrix

Each sample shall be assigned a unique identification number. This number shall be coded according to sample location according to the following format:

AABBGWMYXxxx-b-c

where:

- **AA** indicates the year (two digits) the sampling event started.
- **BB** indicates the month (two digits) the sampling event started.
- **GW** denotes that groundwater is sampled.
- **M** designates “M” for Monsanto and is used to differentiate from other sample stations identified by MWH for Idaho Mine Association (IMA) mine-specific investigations.
- **YY** denotes the station type; station type which is ST for streams, DS for dump seeps, SG for springs, MW for monitoring wells, and BW for borehole monitoring wells.
- **xxx** denotes the specific station number/location.
- **b** denotes the replicate number (no number shall indicate no replicate samples; if there are QA/QC replicate samples, then 1, 2 and 3 represent the replicate samples).
- **c** denotes whether the sample involved special field handling or is to be handled in a specific manner; handling codes are as follows:

F:	Filtered
U:	Unfiltered

As an example, sample number **0905GWMMW020-1-F** describes the first field replicate of a filtered groundwater sample collected at monitoring well MMW020 in May 2009.

4.8 SAMPLE HANDLING AND SHIPPING

Sample containers will be sealed in plastic bags with wire ties and immediately placed on ice in an insulated cooler to ≤ 6 °C. Insulated coolers will be provided by Microbac or purchased locally. All samples will be stored in the coolers and handled as specified in Section 2.0 of the *Q-APP Addendum* (MWH, 2009b). All samples will remain in the coolers until the end of the day when all of the samples will be transferred to a locked refrigerator at the Fox Hills Ranch.

Samples will be shipped to Microbac with bagged wet ice in coolers secured with packing tape, via overnight Federal Express service to Microbac. MWH will fill out appropriate chain-of-custody forms; the chain-of-custody will be included with the sample shipment, and copies of all chains-of-custody along with Federal Express waybills will be kept by MWH field personnel.

All samples will be sent to Microbac at the following address:

Microbac
158 Starlite Drive
Marietta, OH 45750
(740) 373-4071
Attn: Kathy Albertson

Supplies including sample containers and coolers will be sent to the Monsanto Plant:

Monsanto Company
1853 HWY 34
Soda Springs, ID 83276
(208) 547-1439
Attn: Barry Koch

4.9 SAMPLE ANALYSIS

In spring and fall 2009, samples will be analyzed for the groundwater parameters presented in Table 4-3, *Groundwater Analytes*. The analyte list was developed based on recommendations from the A/T and the screening in Section 3.0 of the SAP. Microbac of Marietta, Ohio will analyze for all parameters listed.

TABLE 4-3 GROUNDWATER ANALYTES									
Parameter	2008 MW's & MMW009	2007 & older MWs	BWs and 2009 MWs	Seeps , Springs, & Streams	Basis	Method	RL	Reporting Units	Holding Times (days)
alkalinity	x		x		total	310.2	10	mg/L	14
aluminum	x		x		total	6010B	0.1	mg/L	180
antimony	x				total	6020A	0.1	mg/L	180
arsenic	x				total	6020A	0.001	mg/L	180
barium	x				total	6010B	0.01	mg/L	180
beryllium	x				total	6010B	0.002	mg/L	180
cadmium				x	dissolved	6020A	0.0005	mg/L	180
cadmium	x		x	x	total	6020A	0.0005	mg/L	180
calcium	x		x	x	dissolved	6010B	0.2	mg/L	180
chloride	x		x	x	dissolved	300.0	0.2	mg/L	28
chromium	x		x		total	6020A	0.002	mg/L	180
cobalt	x				total	6020A	0.001	mg/L	180
copper	x				total	6020A	0.002	mg/L	180
gross alpha	x		x		total	900	5	pCi/L	180
gross beta	x		x		total	900	5	pCi/L	180

TABLE 4-3 GROUNDWATER ANALYTES									
Parameter	2008 MW's & MMW009	2007 & older MWs	BWs and 2009 MWs	Seeps, Springs, & Streams	Basis	Method	RL	Reporting Units	Holding Times (days)
hardness	x		x		dissolved	2340B-Calculation	5	mg/L	n/a
iron	x		x		dissolved	6010B	0.1	mg/L	180
iron	x		x		total	6010B	0.1	mg/L	180
lead	x				total	6020A	0.001	mg/L	180
manganese	x		x		total	6020A	0.002	mg/L	180
magnesium	x		x	x	dissolved	6010B	0.5	mg/L	180
mercury	x				total	7471	0.002	mg/L	28
molybdenum	x				total	6010B	0.01	mg/L	180
nickel	x		x		total	6020A	0.004	mg/L	180
nitrogen (total nitrate – nitrite)	x		x		total	353.2	0.05	mg/L	28
potassium	x		x		dissolved	6010B	1	mg/L	180
selenium	x	x	x	x	total	6020A	0.001	mg/L	180
silver	x				total	6020A	0.001	mg/L	180
sodium	x		x		dissolved	6010B	0.5	mg/L	180
sulfate	x	x	x	x	dissolved	300.0	1	mg/L	28
thallium	x				total	6020A	0.0002	mg/L	180
total dissolved solids	x	x	x	x	total	160.1	10	mg/L	7
total suspended solids	x		x		total	160.2	5	mg/L	7
uranium	x				total	6020A	0.040	mg/L	180
vanadium	x		x	x	total	6010B	0.01	mg/L	180
zinc	x		x		total	6020A	0.025	mg/L	180
Notes: Method—Method to be utilized by Microbac MW - Monitoring Well BW – Direct-Push Borehole Well RL—Reporting Limit of Microbac									

4.10 SAMPLING QUALITY ASSURANCE

The following QA/QC procedures will be followed during surface water sampling:

- Collection of QA/QC samples will occur at a minimum rate of 10 percent of total stations.

- A QA/QC sample will consist of three field replicates.
- The equipment rinsate sample will be collected by rinsing decontaminated sampling equipment with deionized water in a manner similar to actual sample collection.
- The source water blank will be a sample of the deionized water used for the equipment rinsate sample.
- Equipment rinsate samples (ERs) will be taken on a daily basis whenever non-dedicated sampling equipment is used. For example, wells with dedicated pumps will not need an equipment rinsate sample taken. Source water blank samples should be collected once at the beginning of each sampling event, and whenever new source water is used. If more than one team collects samples on a given day, ERs will also be taken by each sampling team.
- For matrix spike analysis, field teams will collect additional volume and designate on the chain-of-custody forms that the samples are for matrix spike analysis. Matrix spike samples will be collected on a daily basis.
- All sampling equipment will be decontaminated prior to sample collection.

Refer to the *QAPP Addendum* (MWH, 2009b) for further details regarding surface water sampling QA/QC procedures. The QA/QC samples as well as a summary of all samples are provided on Tables 4-4 through 4-7.

**Table 4-4
Sample Tracker for 2008 Monitoring Wells and MMW009**

Field Sample Identification ^a	Location	Matrix	Filtered (check for yes)	QC Sample Type	Laboratory Parameters										Field Parameters									
					Total Sb, As, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, Ag, Ti, U, Zn (SW6020A)	Total Al, Ba, Be, Fe, Mo, V (SW6010B)	TDS (E160.1)	TSS (E160.2)	Hg (SW 7471)	Gross Alpha, Gross Beta (EPA 900)	Nitrate/nitrite as N (EPA 353.2)	Dissolved SO4, Cl (EPA 300.0)	Dissolved Ca, Fe, Mg, K, Na (EPA 6010B)	Total Alkalinity (EPA 310.2)	Dissolved Hardness (SM2340B-Calc)	Conductivity (µS/cm)	Specific Conductivity (µS/cm @ 25°C)	pH	Dissolved Oxygen (% sat)	Dissolved Oxygen (mg/L)	Oxidation/Reduction Potential (mV)	Turbidity (ftu)	Water Temperature (°C)	Air Temperature (°C)
0905GWMW024-U	MMW024	Water		Primary	X	X	X	X	X	X							X	X		X	X	X	X	
0905GWMW024-F	MMW024	Water	X	Primary								X				X	X		X	X	X	X	X	
0905GWMW025-U	MMW025	Water		Primary	X	X	X	X	X	X									X	X	X	X	X	
0905GWMW025-F	MMW025	Water	X	Primary								X	X	X	X	X			X	X	X	X	X	
0905GWMW026-U	MMW026	Water		Primary	X	X	X	X	X	X									X	X	X	X	X	
0905GWMW026-F	MMW026	Water	X	Primary								X	X	X	X	X			X	X	X	X	X	
0905GWMW027-U	MMW027	Water		Primary	X	X	X	X	X	X									X	X	X	X	X	
0905GWMW027-F	MMW027	Water	X	Primary								X	X	X	X	X			X	X	X	X	X	
0905GWMW028-U	MMW028	Water		Primary	X	X	X	X	X	X									X	X	X	X	X	
0905GWMW028-F	MMW028	Water	X	Primary								X	X	X	X	X			X	X	X	X	X	
0905GWMW029-U	MMW029	Water		Primary	X	X	X	X	X	X									X	X	X	X	X	
0905GWMW029-F	MMW029	Water	X	Primary								X	X	X	X	X			X	X	X	X	X	
0905GWMW030-U	MMW030	Water		Primary	X	X	X	X	X	X									X	X	X	X	X	
0905GWMW030-F	MMW030	Water	X	Primary								X	X	X	X	X			X	X	X	X	X	
0905GWMW031-U	MMW031	Water		Primary	X	X	X	X	X	X									X	X	X	X	X	
0905GWMW031-F	MMW031	Water	X	Primary								X	X	X	X	X			X	X	X	X	X	
0905GWMW009-U	MMW009	Water		Primary	X	X	X	X	X	X									X	X	X	X	X	
0905GWMW009-F	MMW009	Water	X	Primary								X	X	X	X	X			X	X	X	X	X	
0905GWMW15A-U	MW-15A	Water		Primary	X	X	X	X	X	X									X	X	X	X	X	
0905GWMW15A-F	MW-15A	Water	X	Primary								X	X	X	X	X			X	X	X	X	X	
0905GWMW16A-U	MW-16A	Water		Primary	X	X	X	X	X	X									X	X	X	X	X	
0905GWMW16A-F	MW-16A	Water	X	Primary								X	X	X	X	X			X	X	X	X	X	
0905B-GW-10-U	na	Water		B	X	X	X	X	X	X														
0905B-GW-10-F	na	Water	X	B								X	X	X	X	X								
0905B-GW-11-U	na	Water		B	X	X	X	X	X	X														
0905B-GW-11-F	na	Water	X	B								X	X	X	X	X								
0905B-GW-12-U	na	Water		B	X	X	X	X	X	X														
0905B-GW-12-F	na	Water	X	B								X	X	X	X	X								
0905B-GW-13-U	na	Water		B	X	X	X	X	X	X														
0905B-GW-13-F	na	Water	X	B								X	X	X	X	X								
0905B-GW-14-U	na	Water		B	X	X	X	X	X	X														
0905B-GW-14-F	na	Water	X	B								X	X	X	X	X								

B – source water blank sample, to be taken once at the beginning of each sampling event and whenever new source water is used.

ID - identification

na - not applicable

QC - quality control

^a Sample Identification will also include a date prefix reflecting the year and month the sample was taken. For example, a sample taken in June of 2009 would have a prefix of (0906) followed by the normal sample ID.

MWH

AUGUST 2009

2009 GROUNDWATER MONITORING

FSP

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Table 4-5
Sample Tracker for Direct Push Borehole Wells and 2008 and 2009 Monitoring Wells

Field Sample Identification ^a	Location	Matrix	Filtered (check for yes)	QC Sample Type	Laboratory Parameters										Field Parameters									
					Total Cd, Cr, Mn, Se, Ni, Zn (SW6020A)	Total Al, Fe, V (SW6010B)	TDS (E160.1)	TSS (E160.2)	Gross Alpha, Gross Beta (EPA 900)	Nitrate/nitrite as N (EPA 353.2)	Dissolved SO ₄ , Cl (EPA 300.0)	Dissolved Ca, Fe, Mg, K, Na (EPA 6010B)	Total Alkalinity (EPA 310.2)	Dissolved Hardness (SM2340B-Calc)	Conductivity (µS/cm)	Specific Conductivity (µS/cm @ 25°C)	pH	Dissolved Oxygen (% sat)	Dissolved Oxygen (mg/L)	Oxidation/Reduction Potential (mV)	Turbidity (ftu)	Water Temperature (°C)	Air Temperature (°C)	Discharge (ft ³ /sec)
0905GWMBW006-U	MBW006	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMBW006-F	MBW006	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMBW009-U	MBW009	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMBW009-F	MBW009	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMBW011-U	MBW011	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMBW011-F	MBW011	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMBW026-U	MBW026	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMBW026-F	MBW026	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMBW027-U	MBW027	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMBW027-F	MBW027	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMBW028-U	MBW028	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMBW028-F	MBW028	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMBW032-U	MBW032	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMBW032-F	MBW032	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMBW048-U	MBW048	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMBW048-F	MBW048	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMBW085-U	MBW085	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMBW085-F	MBW085	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMBW087-U	MBW087	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMBW087-F	MBW087	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMBW099-U	MBW099	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMBW099-F	MBW099	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMBW107-U	MBW107	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMBW107-F	MBW107	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	

Table 4-5
Sample Tracker for Direct Push Borehole Wells and 2008 and 2009 Monitoring Wells

Field Sample Identification ^a	Location	Matrix	Filtered (check for yes)	QC Sample Type	Laboratory Parameters										Field Parameters									
					Total Se, Cd, Cr, Mn, Ni, Zn (SW6020A)	Total Al, Fe, V (SW6010B)	TDS (E160.1)	TSS (E160.1)	Gross Alpha, Gross Beta (EPA 900)	Nitrogen (Total nitrate-nitrite) (EPA 353.2)	Dissolved S04, Cl (EPA 300.0)	Dissolved Ca, Fe, Mg, K, Na (EPA 6010B)	Total Alkalinity (EPA 310.2)	Dissolved Hardness (SM2340B-Calc)	Conductivity (µS/cm)	Specific Conductivity (µS/cm @ 25°C)	pH	Dissolved Oxygen (% sat)	Dissolved Oxygen (mg/L)	Oxidation/Reduction Potential (mV)	Turbidity (ftu)	Water Temperature (°C)	Air Temperature (°C)	Discharge (ft ³ /sec)
0905GWMBW112-U	MBW112	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMBW112-F	MBW112	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMMW032-U	MMW032	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMMW032-F	MMW032	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMMW033-U	MMW033	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMMW033-F	MMW033	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMMW034-U	MMW034	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMMW034-F	MMW034	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMMW035-U	MMW035	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMMW035-F	MMW035	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905GWMMW036-U	MMW036	Water		Primary	X	X	X	X	X							X	X		X	X	X	X	X	
0905GWMMW036-F	MMW036	Water	X	Primary						X	X	X	X	X		X	X		X	X	X	X	X	
0905B-GW-10-U	na	Water		B	X	X	X	X	X															
0905B-GW-10-F	na	Water	X	B						X	X	X	X	X										
0905B-GW-11-U	na	Water		B	X	X	X	X	X															
0905B-GW-11-F	na	Water	X	B						X	X	X	X	X										
0905B-GW-12-U	na	Water		B	X	X	X	X	X															
0905B-GW-12-F	na	Water	X	B						X	X	X	X	X										
0905B-GW-13-U	na	Water		B	X	X	X	X	X															
0905B-GW-13-F	na	Water	X	B						X	X	X	X	X										
0905B-GW-14-U	na	Water		B	X	X	X	X	X															
0905B-GW-14-F	na	Water	X	B						X	X	X	X	X										

B – source water blank sample, to be taken once at the beginning of each sampling event and whenever new source water is used.

ID - identification

na - not applicable

QC - quality control

^a Sample Identification will also include a date prefix reflecting the year and month the sample was taken. For example, a sample taken in June of 2009 would have a prefix of (0906) followed by the normal sample ID.

**Table 4-6
Sample Tracker for 2007 and Older Monitoring Wells**

Field Sample Identification ^a	Location	Matrix	Filtered (check for yes)	QC Sample Type	Lab Parameters			Field Parameters										
					Total Se (SW6020A)	TDS (E 160.1)	SO4 (EPA 300.0)		Conductivity (µS/cm)	Specific Conductivity (µS/cm @ 25°C)	pH	Dissolved Oxygen (% sat)	Dissolved Oxygen (mg/L)	Oxidation/Reduction Potential (mV)	Turbidity (ftu)	Water Temperature (°C)	Air Temperature (°C)	Discharge (ft ³ /sec)
09095GWMMW004-U	MMW004	Water		Primary	X	X				X	X		X	X	X	X	X	
09095GWMMW004-F	MMW004	Water	X	Primary			X			X	X		X	X	X	X	X	
09095GWMMW006-U	MMW006	Water		Primary	X	X				X	X		X	X	X	X	X	
09095GWMMW006-F	MMW006	Water	X	Primary			X			X	X		X	X	X	X	X	
09095GWMMW007-U	MMW007	Water		Primary	X	X				X	X		X	X	X	X	X	
09095GWMMW007-F	MMW007	Water	X	Primary			X			X	X		X	X	X	X	X	
09095GWMMW008-U	MMW008	Water		Primary	X	X				X	X		X	X	X	X	X	
09095GWMMW008-F	MMW008	Water	X	Primary			X			X	X		X	X	X	X	X	
09095GWMMW010-U	MMW010	Water		Primary	X	X				X	X		X	X	X	X	X	
09095GWMMW010-F	MMW010	Water	X	Primary			X			X	X		X	X	X	X	X	
09095GWMMW011-U	MMW011	Water		Primary	X	X				X	X		X	X	X	X	X	
09095GWMMW011-F	MMW011	Water	X	Primary			X			X	X		X	X	X	X	X	
09095GWMMW012-U	MMW012	Water		Primary	X	X				X	X		X	X	X	X	X	
09095GWMMW012-F	MMW012	Water	X	Primary			X			X	X		X	X	X	X	X	
09095GWMMW013-1-U	MMW013	Water		Triplicate	X	X				X	X		X	X	X	X	X	
09095GWMMW013-1-F	MMW013	Water	X	Triplicate			X			X	X		X	X	X	X	X	
09095GWMMW013-2-U	MMW013	Water		Triplicate	X	X				X	X		X	X	X	X	X	
09095GWMMW013-2-F	MMW013	Water	X	Triplicate			X			X	X		X	X	X	X	X	
09095GWMMW013-3-U	MMW013	Water		Triplicate	X	X				X	X		X	X	X	X	X	
09095GWMMW013-3-F	MMW013	Water	X	Triplicate			X			X	X		X	X	X	X	X	
09095GWMMW014-U	MMW014	Water		Primary	X	X				X	X		X	X	X	X	X	
09095GWMMW014-F	MMW014	Water	X	Primary			X			X	X		X	X	X	X	X	
09095GWMMW017-U	MMW017	Water		Primary	X	X				X	X		X	X	X	X	X	
09095GWMMW017-F	MMW017	Water	X	Primary			X			X	X		X	X	X	X	X	
09095GWMMW018-U	MMW018	Water		Primary	X	X				X	X		X	X	X	X	X	
09095GWMMW018-F	MMW018	Water	X	Primary			X			X	X		X	X	X	X	X	

Table 4-6
Sample Tracker for 2007 and Older Monitoring Wells

Field Sample Identification ^a	Location	Matrix	Filtered (check for yes)	QC Sample Type	Lab Parameters			Field Parameters										
					Total Se (SW6020A)	TDS (E 160.1)	S04 (EPA 300.0)		Conductivity (µS/cm)	Specific Conductivity (µS/cm @ 25°C)	pH	Dissolved Oxygen (% sat)	Dissolved Oxygen (mg/L)	Oxidation/Reduction Potential (mV)	Turbidity (ftu)	Water Temperature (°C)	Air Temperature (°C)	Discharge (ft³/sec)
0905GWMW019-U	MMW019	Water		Primary	X	X				X	X		X	X	X	X	X	
0905GWMW019-F	MMW019	Water	X	Primary			X			X	X		X	X	X	X	X	
0905GWMW020-U	MMW020	Water		Primary	X	X				X	X		X	X	X	X	X	
0905GWMW020-F	MMW020	Water	X	Primary			X			X	X		X	X	X	X	X	
0905GWMW021-1-U	MMW021	Water		Triplicate	X	X				X	X		X	X	X	X	X	
0905GWMW021-1-F	MMW021	Water	X	Triplicate			X			X	X		X	X	X	X	X	
0905GWMW021-2-U	MMW021	Water		Triplicate	X	X				X	X		X	X	X	X	X	
0905GWMW021-2-F	MMW021	Water	X	Triplicate			X			X	X		X	X	X	X	X	
0905GWMW021-3-U	MMW021	Water		Triplicate	X	X				X	X		X	X	X	X	X	
0905GWMW021-3-F	MMW021	Water	X	Triplicate			X			X	X		X	X	X	X	X	
0905GWMW022-U	MMW022	Water		Primary	X	X				X	X		X	X	X	X	X	
0905GWMW022-F	MMW022	Water	X	Primary			X			X	X		X	X	X	X	X	
0905GWMW023-U	MMW023	Water		Primary	X	X				X	X		X	X	X	X	X	
0905GWMW023-F	MMW023	Water	X	Primary			X			X	X		X	X	X	X	X	
0905B-GW-05-U	na	Water		B	X	X												
0905B-GW-05-F	na	Water	X	B			X											
0905B-GW-06-U	na	Water		B	X	X												
0905B-GW-06-F	na	Water	X	B			X											
0905B-GW-07-U	na	Water		B	X	X												
0905B-GW-07-F	na	Water	X	B			X											
0905B-GW-08-U	na	Water		B	X	X												
0905B-GW-08-F	na	Water	X	B			X											
0905B-GW-09-U	na	Water		B	X	X												
0905B-GW-09-F	na	Water	X	B			X											

B – source water blank sample, to be taken once at the beginning of each sampling event and whenever new source water is used.

ID - identification

na - not applicable

QC - quality control

^a Sample Identification will also include a date prefix reflecting the year and month the sample was taken. For example, a sample taken in June of 2009 would have a prefix of (0906) followed by the normal sample ID.

**Table 4-7
Sample Tracker for Seeps, Springs, and Streams**

Field Sample Identification ^a	Location	Matrix	Filtered (check for yes)	QC Sample Type	Laboratory Parameters							Field Parameters										
					Total Se, Cd (SW6020A)	Total V (EPA6010B)	Dissolved Cd (EPA6020A)	Dissolved Cl, S04 (EPA 300.0)	Dissolved Ca, Mg (EPA 6010B)	Total Dissolved Solids (EPA 160.1)			Conductivity (µS/cm)	Specific Conductivity (µS/cm @ 25°C)	pH	Dissolved Oxygen (% sat)	Dissolved Oxygen (mg/L)	Oxidation/Reduction Potential (mV)	Turbidity (ftu)	Water Temperature (°C)	Air Temperature (°C)	Discharge (ft ³ /sec)
0905GWMSG004-U	MSG004	Water		Primary	X	X					X		X	X	X	X	X	X	X	X	X	
0905GWMSG004-F	MSG004	Water	X	Primary			X	X	X				X	X	X	X	X	X	X	X	X	
0905GWMSG005-1-U	MSG005	Water		Triplicate	X	X					X		X	X	X	X	X	X	X	X	X	
0905GWMSG005-1-F	MSG005	Water	X	Triplicate			X	X	X				X	X	X	X	X	X	X	X	X	
0905GWMSG005-2-U	MSG005	Water		Triplicate	X	X					X		X	X	X	X	X	X	X	X	X	
0905GWMSG005-2-F	MSG005	Water	X	Triplicate			X	X	X				X	X	X	X	X	X	X	X	X	
0905GWMSG005-3-U	MSG005	Water		Triplicate	X	X					X		X	X	X	X	X	X	X	X	X	
0905GWMSG005-3-F	MSG005	Water	X	Triplicate			X	X	X				X	X	X	X	X	X	X	X	X	
0905GWMSG006-U	MSG006	Water		Primary	X	X					X		X	X	X	X	X	X	X	X	X	
0905GWMSG006-F	MSG006	Water	X	Primary			X	X	X				X	X	X	X	X	X	X	X	X	
0905GWMSG007-U	MSG007	Water		Primary	X	X					X		X	X	X	X	X	X	X	X	X	
0905GWMSG007-F	MSG007	Water	X	Primary			X	X	X				X	X	X	X	X	X	X	X	X	
0905GWMDS025-U	MDS025	Water		Primary	X	X					X		X	X	X	X	X	X	X	X	X	
0905GWMDS025-F	MDS025	Water	X	Primary			X	X	X				X	X	X	X	X	X	X	X	X	
0905GWMDS026-1-U	MDS026	Water		Triplicate	X	X					X		X	X	X	X	X	X	X	X	X	
0905GWMDS026-1-F	MDS026	Water	X	Triplicate			X	X	X				X	X	X	X	X	X	X	X	X	
0905GWMDS026-2-U	MDS026	Water		Triplicate	X	X					X		X	X	X	X	X	X	X	X	X	
0905GWMDS026-2-F	MDS026	Water	X	Triplicate			X	X	X				X	X	X	X	X	X	X	X	X	
0905GWMDS026-3-U	MDS026	Water		Triplicate	X	X					X		X	X	X	X	X	X	X	X	X	
0905GWMDS026-3-F	MDS026	Water	X	Triplicate			X	X	X				X	X	X	X	X	X	X	X	X	
0905GWMDS030-U	MDS030	Water		Primary	X	X					X		X	X	X	X	X	X	X	X	X	
0905GWMDS030-F	MDS030	Water	X	Primary			X	X	X				X	X	X	X	X	X	X	X	X	
0905GWMDS034-U	MDS034	Water		Primary	X	X					X		X	X	X	X	X	X	X	X	X	
0905GWMDS034-F	MDS034	Water	X	Primary			X	X	X				X	X	X	X	X	X	X	X	X	

Table 4-7
Sample Tracker for Seeps, Springs, and Streams

					Laboratory Parameters							Field Parameters										
Field Sample Identification ^a	Location	Matrix	Filtered (check for yes)	QC Sample Type	Total Se, Cd (SW6020A)	Total V (EPA6010B)	Dissolved Cd (EPA6020A)	Dissolved Cl, S04 (EPA 300.0)	Dissolved Ca, Mg, K, Na (EPA 6010B)	Total Dissolved Solids (EPA 160.1)		Conductivity (µS/cm)	Specific Conductivity (µS/cm @ 25°C)	pH	Dissolved Oxygen (% sat)	Dissolved Oxygen (mg/L)	Oxidation/Reduction Potential (mV)	Turbidity (ftu)	Water Temperature (°C)	Air Temperature (°C)	Discharge (ft³/sec)	
0905GWMST069-U	MST069	Water		Primary	X	X				X		X	X	X	X	X	X	X	X	X	X	
0905GWMST069-F	MST069	Water	X	Primary			X	X	X			X	X	X	X	X	X	X	X	X	X	
0905GWMST096-U	MST096	Water		Primary	X	X				X		X	X	X	X	X	X	X	X	X	X	
0905GWMST096-F	MST096	Water	X	Primary			X	X	X			X	X	X	X	X	X	X	X	X	X	
0905GWMST136-U	MST136	Water		Primary	X	X				X		X	X	X	X	X	X	X	X	X	X	
0905GWMST136-F	MST136	Water	X	Primary			X	X	X			X	X	X	X	X	X	X	X	X	X	
0905GWMST144-U	MST144	Water		Primary	X	X				X		X	X	X	X	X	X	X	X	X	X	
0905GWMST144-F	MST144	Water	X	Primary			X	X	X			X	X	X	X	X	X	X	X	X	X	
0905ER-GW-01-U	na	Water		ER	X	X				X												
0905ER-GW-01-F	na	Water	X	ER			X	X	X													
0905ER-GW-02-U	na	Water		ER	X	X				X												
0905ER-GW-02-F	na	Water	X	ER			X	X	X													
0905ER-GW-03-U	na	Water		ER	X	X				X												
0905ER-GW-03-F	na	Water	X	ER			X	X	X													
0905ER-GW-04-U	na	Water		ER	X	X				X												
0905ER-GW-04-F	na	Water	X	ER			X	X	X													
0905B-GW-01-U	na	Water		B	X	X				X												
0905B-GW-01-F	na	Water	X	B			X	X	X													
0905B-GW-02-U	na	Water		B	X	X				X												
0905B-GW-02-F	na	Water	X	B			X	X	X													
0905B-GW-03-U	na	Water		B	X	X				X												
0905B-GW-03-F	na	Water	X	B			X	X	X													
0905B-GW-04-U	na	Water		B	X	X				X												
0905B-GW-04-F	na	Water	X	B			X	X	X													

ER - equipment rinsate blank sample, to be taken once per field team per day from non-dedicated sampling equipment, total ERs taken may not add up to what is accounted for here

B – source water blank sample, to be taken once at the beginning of each sampling event and whenever new source water is used.

ID - identification

na - not applicable

QC - quality control

^a Sample Identification will also include a date prefix reflecting the year and month the sample was taken. For example, a sample taken in June of 2009 would have a prefix of (0906) followed by the normal sample ID.

5.0 PROJECT ORGANIZATION

5.1 PROJECT TEAM

The project team member information is presented below. Contact information for each member of the project team is presented in Table 5-1, *Project Contacts*. The field team leader will submit a daily update to P4 and MWH program managers that contains a report of daily progress, any variances from planned work for the day, anticipated work for the next day, and any other problems or assistance required. The field team leader will also perform a thorough review of the day's field sampling forms and update the tracker table according to the day's activities (i.e., stations sampled with sample ID's and field parameters taken). This process will procure an extra step in the QA/QC process to help ensure every sample is taken and that nothing is missed. All updates will be submitted via e-mail.

Groundwater Sampling Project Team:

- Barry Koch – P4 Program Manager
- Paul Stenhouse – P4 Environmental Regulatory Specialist
- Cary Foulk – MWH Project Manager
- Colin Duffy – Field Team Leader / Program Safety Officer
- Dean Brame – Assistant Field Team Leader / Field QC Manager
- Ruth Siegmund – Program Quality Manager
- Celeste Christensen – Program Control
- Elaine Smith – Database Manager
- Edmund Ling – Project Chemist
- Microbac – Contracted Analytical Laboratory
- Laboratory Data Consultants (LDC) – Contracted Third Party Validation

TABLE 5-1 PROJECT CONTACTS			
Company or Agency	Contact	Title	Telephone
P4 Production	Barry Koch	Special Project Lead—Mining / Program Manager	208-547-1439
	Bob Geddes	Environmental Regulatory Specialist / Management Support	208-547-1234
	Paul Stenhouse	Environmental Regulatory Specialist	208-547-1294
Idaho Department of Environmental Quality	Mike Rowe	Program Manager and On Scene Coordinator	208-236-6160
MWH	Cary Foulk	Program Manager and Supervising Geologist / Geochemist	970-879-6260
	Bill Wright	Technical Support and Principal Ecologist	425-241-7413
	Ruth Siegmund	Program Quality Manager	925-627-4756
	Colin Duffy	Field Team Leader / Program Safety Officer	425-896-6900
	Dean Brame	Assistant Field Team Leader / Field QC Manager	425-896-6900
	Suzanne Anderson	Analytical Task Manager and Technical & Field Support	425-896-6900
	Celeste Christensen	Project Coordinator	425-896-6900
	Edmund Ling	Project Chemist	925-627-4620
	Elaine Smith	Database Manager	925-627-4659
Microbac Laboratories, Inc.	Kathy Albertson	Project Manager (laboratory)	800-373-4071 x179
Laboratory Data Consultants, Inc	Linda Rauto	Project Manager (data validation subcontractor)	760-634-0437

5.2 PROJECT SCHEDULE

- Sampling – spring and fall 2009
- Data validation – within 60 days of receipt of laboratory data
- Data Summary Report – within 60 days of final, validated data set approval by the A/T or as agreed to for overall annual Data Summary Report.

5.3 PROJECT DELIVERABLES

The raw data and data validation reports will be submitted to the A/T when available. Once the validated sampling data are approved by the A/T, a Groundwater Sampling Data Summary Report will be submitted. This report will include:

- Field activity summary
- Data summary and detailed tables

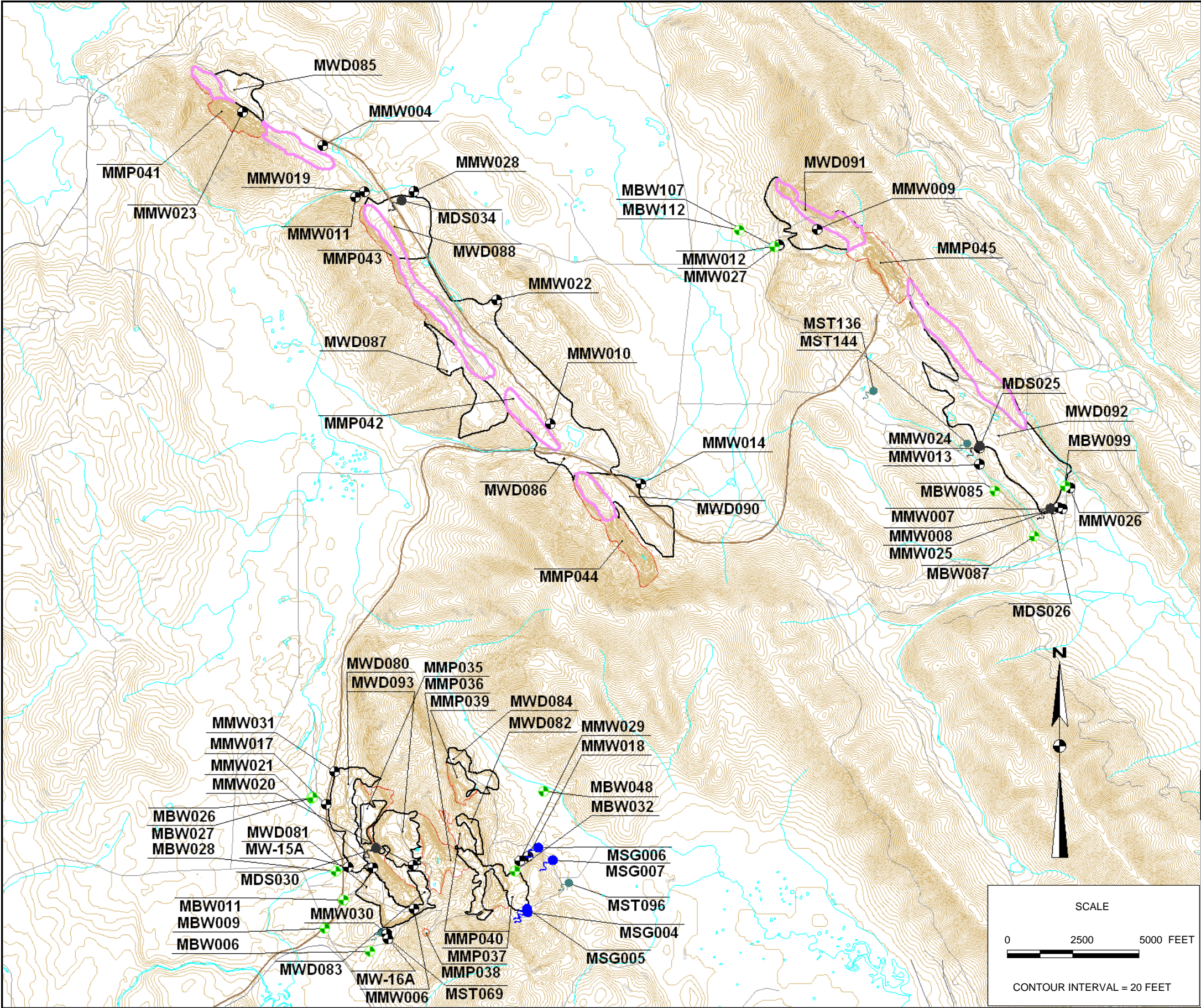
- Figures presenting spatial distribution of data
- Statistical analysis of the data

This report may be incorporated within the overall Data Summary Report for the year's activities for the overall characterization project, or if the characterization component of the project is completed the data will be incorporated into the Site Investigation or Remedial Investigation report.

6.0 REFERENCES

- MWH, 2004. *Comprehensive Site Investigation, Enoch Valley (Henry or Ballard) Mine Work Plan – Final, P4 Production’s Southeast Idaho Mine-Specific Selenium Program*. Prepared for P4 Production. March.
- MWH, 2008. *Conditional Final - 2007 Hydrogeologic Data Collection Activities and Updated Conceptual Models - Interim Report for Hydrogeologic Investigation*. July.
- MWH, 2009a. *Draft 2007 and 2008 Data Summary Report Mines Site Investigation*. Prepared for P4 Production. March.
- MWH, 2009b. *Quality Assurance Project Plan Addendum Program Quality Assurance Plan*. Prepared for P4 Production. January.
- P4, 2009. *Direct Push Groundwater Continuation Sampling and Analysis Plan*. April.
- Rantz, S.E., et al. 1982. *Measurement and Computation of Streamflow: Volume 1; Measurement of Stage and Discharge*. Geological Survey Water-Supply Paper 2175. U.S. Government Printing Office. Washington, D.C.

DRAWINGS



LEGEND

7000

CONTOURS

CREEKS/RIVERS

ROADS

HAUL ROAD

WASTE ROCK PILE LOCATION (APPROXIMATE)

MINE PIT LOCATION (APPROXIMATE)

GROUNDWATER WELL MONITORING LOCATIONS

BOREHOLE MONITORING WELL

SPRING STATION

WASTE ROCK DUMP SEEP

STREAM STATION

BACKFILLED PIT

MBW = BOREHOLE MONITORING WELL

MDS = DUMP SEEP

MMP = MINE PIT

MMW = MONITORING WELL

MSG = SPRING

MST = STREAM

MWD = WASTE ROCK DUMP

NOTES:

- PRE-MINE TOPOGRAPHY ID FROM USGS DIGITAL ELEVATION MODELS (DEM)-24K AND DIGITAL LINE GRAPHS (DLG) FOR HENRY, ID; WAYAN WEST, ID; CHINA HAT, ID; JOHNSON CREEK, ID; SODASPRINGS, ID; WAYAN EAST, ID; UPPER VALLEY, ID; DRY VALLEY ID AND LOWER VALLEY, ID.
- PRE-MINE TOPOGRAPHY PROJECTION IS A MODIFIED IDAHO EAST STATE PLANE COORDINATE SYSTEM, NAD 27.

SCALE
0 2500 5000 FEET
CONTOUR INTERVAL = 20 FEET

SOP-NW-9.1

Collection of Surface Water Samples

Note: This document is proprietary, revision controlled, and is intended strictly for use by MWH and its teaming partners or subcontractors in support of specific contractual responsibilities. Copying and further dissemination in any manner is not permitted without written authorization by the responsible MWH Project Manager, except as may be agreed upon by MWH and its clients in the terms and conditions of applicable contracts.

1.0 SCOPE

The purpose of this document is to define the standard operating procedures (SOP) for the collection and handling of surface water samples. This SOP applies to any work performed by MWH or subcontractor personnel for any portion of surface water sampling and is intended for use in conjunction with site-specific workplans or sampling and analysis plans (SAPs). Modifications to this SOP may be made with approval of the Project Manager or Task Leader and the Quality Assurance (QA) Manager. Sampling locations shall be as specified in the governing workplan or SAP.

2.0 RESPONSIBILITIES

2.1 Field Sampling Engineer

The Field Sampling Engineer is responsible for sample collection, sample custody in the field, sample preservation, field testing, total and accurate completion of data sheets, sample shipment and delivery of data to the Project Manager, as described in this technical procedure. All staff are responsible for reporting deviations or nonconformance of the procedure to the Field Team Leader, Project Manager, or Quality Assurance (QA) Manager, in compliance with the governing workplan or SAP requirements.

2.2 Field Team Leader

The Field Team Leader is responsible for supervising the Field Sampling Engineers. Supervision includes ensuring that samples are collected, documented, preserved, field analyzed, handled and shipped to the appropriate laboratory as specified in project work documents and this technical procedure.

2.3 Project Manager

The Project Manager has overall management responsibilities for the project, is responsible for designing the sampling program, for arranging the logistics of the program, and for providing any required clarifications in the use of this procedure. The Project Manager may assume the responsibilities of the Field Team Leader on smaller projects.

The Project Manager is also responsible for maintaining project files and filing project documents, project correspondence, chain of custody forms, sediment sampling forms, generated data, and other associated and pertinent project information.

2.4 QA Manager

The QA Manager is responsible for developing and managing procedures outlined in the SOPs and in site specific SAPs, QA plans, and/or workplans.

3.0 DISCUSSION

The methods described by this procedure may be used to acquire water samples for chemical or radiological analysis. Methods should be selected at the discretion of the Field Team Leader or Project Manager in accordance with any specific provisions of governing SAPs, QA plans, and/or workplans.

4.0 PROCEDURES

The sampling methods described in this SOP are suitable for collecting water samples that are located at or near active and historic phosphate mines in the southeast Idaho project area. This SOP describes collecting surface water samples at four different types of water bodies, streams, seeps, reservoir or lakes, and standing water locations (ponds). Sample documentation and labeling, as well as, sampling frequency, locations, volumes and analyses shall be as specified in the governing workplan or SAP.

4.1 Decontamination

Before sampling at a new location, all water sample collection equipment will be decontaminated by rinsing the water collection equipment three times with source water, or as specified in the governing workplan or SAP.

4.2 Instrument Calibration

Electronic equipment used during sampling to obtain field parameters will include, but is not limited to, a pH meter with automatic temperature compensation, a specific conductivity meter, a dissolved oxygen meter, a turbidity meter, and an oxidation-reduction potential meter (ORP or eH). Before going into the field, the field team leader will verify that all equipment is operating properly. Calibration, times and appropriate readings will be recorded in the field notebook and as specified in the governing workplan or SAP. Meters will be calibrated according to manufacturer's instructions.

4.3 Filtering

Samples to be analyzed for dissolved state will be filtered during the field sampling event by using a disposable 0.45 micron filter apparatus and peristaltic pump, vacuum pump, syringe, or equivalent equipment. Other samples for a particular analysis may require filtering as specified in the governing workplan or SAP. Filtered samples will be collected according to the following procedure:

- Assemble filter device according to manufacturer's instructions.
- Filter sample either by pouring sample in the top portion of filter unit or pumping it through an in-line filter using the pump or syringe.

- Transfer filtered sample to appropriate sample bottle with required preservative.
- Dispose of the used filter and tubing.
- Decontaminate any reusable filtering equipment. Place decontaminated equipment in a clean plastic bag or container for transportation between sampling locations.

4.4 Obtaining Water Samples

The following general procedures will be used before collecting surface water samples:

- Describe physical characteristics of the water source to be sampled, including type (seep, pond, stream, reservoir, lake, etc.), any visual discoloration of water, odor, clarity, or any other notable characteristic of the water source.
- Collect field measurements of water quality parameters.
- Assemble all necessary sample collection and filtering equipment.
- Make sure that the sample labels have been correctly filled out for the sampling location. Assemble bottles for filling.
- Decontaminate sample collection equipment by rinsing the equipment three times with source water.
- Collect water sample. Ideally, the sample will be taken from a point away from where the rinsing of collection equipment occurred when sampling standing water or upstream of the rinsing point when collecting flowing water. The water collection container will be lowered into the water, taking care to avoid collecting items floating in the water and disturbing any sediment during sample collection. After the container is filled, carefully lift it out of the water and empty it into a clean sample composite container. Repeat the process at the sampling location until a sufficient amount of sample has been placed into the composite container as described below. The amount of sample to be composited shall be as specified in the governing workplan or SAP.
- Transfer to appropriately labeled containers

4.4.1 Seeps

Water samples will be collected by immersing the sample transfer container as described above, or for a raw sample, the sample container in the water source. This collection method results in a grab sample that characterizes the medium at a point in space and time, and assumes that the water body sampled (seep) is

homogeneously mixed and has no stratification. Water sample collection from seeps will be done closest to the point of discharge as possible, to minimize contamination from surficial contact.

4.4.2 Ponds

Water samples will be collected by immersing the sample transfer container as described above, or for a raw sample, the sample container in the water source. This collection method results in a grab sample that characterizes the medium at a point in space and time, and assumes that the water body sampled (pond) is homogeneously mixed and has no stratification due to its small size. Collecting water samples from standing water will have the emphasis placed upon the sampler not to disturb the water to be sampled, and the use of a swing sampler to collect as far from the shoreline as possible. This method will be especially important when collecting samples from ponds that have loose material and high gradient slopes that define the pond shoreline, which is typical of mine pit ponds. This will also be important to minimize the immersion risk of sampling personnel. Water samples for ponds may be collected from any point along the shoreline.

4.4.3 Streams and Rivers

Samples will be collected from the same cross section of the stream as that which is used for the discharge (flow) measurement, if discharge is measured. Samples will always be collected prior to making discharge measurements. The sampler will stand downstream of the water to be sampled if safe to do so. If sampling multiple stations on the same stream, downstream samples will always be collected first. Prior to sampling, the stream will be observed for any upstream activities or events that may affect the sample quality. If such events are occurring, the sample will not be collected until the stream clears and the occurrence will be recorded in the field notes.

Selection of sampling methods and equipment based on flow conditions is as follows:

- If the stream is less than 10 ft wide, the sample will be collected from the center of the flow at mid-depth.
- If the stream is greater than 10 ft wide, one composite, consisting of three samples will be collected. The water samples will be taken at $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ of the distance across the river or stream cross-section. These samples should be taken at mid-depth in the water column at each location across the stream channel. All three samples will be composited into one larger container, and apportioned as necessary, into the appropriate sample containers.

Water will be collected from smaller streams and rivers using a standard Kemmerer or Van Dorn horizontal water bottle sampler with the field technician standing downstream and to the side of the bottle. The sampler is a plastic cylinder with rubber stoppers that leave the ends open while being lowered to allow free passage of water through the cylinder. The Kemmerer horizontal water bottle sampler may need to be lowered on a line to reach the desired depth. Once the sampler reaches the desired depth, a 'messenger' is sent down the line, causing the stoppers to close the cylinder, which is then raised. In shallow and faster moving streams and rivers,

operation of the Kemmerer horizontal water bottle sampler will be done by hand, and not with a ‘messenger’. The water inside the sampler will then be transferred to a clean composite container. The process will be repeated at the sampling location until a sufficient amount of sample has been placed into the composite container. When a sufficient amount has been collected, transfer the water from the composite container into the appropriate sample containers. If unsafe wadding conditions exist (i.e., deep water, fast flowing water, slippery surfaces, etc.) a swing sampler will be utilized instead of the horizontal water bottle sampler to collect sample water for compositing. The method of sample collection shall be recorded in the field notebook.

4.4.4 Reservoirs and Lakes

Each lake and/or reservoir sample consists of collecting and compositing samples at several depths along a vertical profile using a standard Kemmerer or Van Dorn horizontal water bottle sampler. This collection method results in a vertically composited sample that characterizes the medium at a point in space and time, and takes into account the possibility of the water body sampled (i.e., reservoir or lake) is not homogeneously mixed and may be stratified. The sampler is a plastic cylinder with rubber stoppers that leave the ends open while being lowered to allow free passage of water through the cylinder. Once the sampler reaches the desired depth, a ‘messenger’ is sent down the line to cause the stoppers to close the cylinder, which is then raised. The water inside the sampler will then be transferred to a clean composite container. Repeat the process at the sampling location until a sufficient amount of sample has been placed into the composite container. When a sufficient amount has been collected, transfer the water from the composite container into the appropriate sample containers. A boat shall be utilized to collect samples from reservoirs and lakes.

4.5 Sampling Documentation

A field sampling data sheet will be completed at each sample location. Items not applicable to the sampling will be labeled as not applicable (NA). Sampling information will also be recorded in a bound field notebook. The information recorded on the data sheet and in the field notebook will include the following:

- Sampling location
- Date and time of sampling
- Persons performing the sampling
- Field water quality parameter measurements (specific conductivity, temperature, dissolved oxygen, pH, oxidation-reduction potential, etc.)
- Physical description of the water body to be sampled (color, odor, etc.)
- Sample identification numbers
- Number of samples taken- note containers, analytes, filtering and preservation methods
- Identification numbers of any QC samples from the site
- Any irregularities or problems which may have a bearing on sample quality

4.6 Equipment List

Sample bottles and preservatives (ultra-pure or metal grade nitric acid) will be obtained from the laboratory selected to perform the chemical analyses of the samples. Extra sample bottles with appropriate preservatives will be obtained in case of breakage or other problems.

Equipment used during surface water sample collection includes:

- Camera
- Chain of custody
- Coolers with ice/blue ice
- Copy of this SOP, SOP-NW-9.2 and -9.2a (if applicable) and the governing workplan or SAP
- Dissolved oxygen meter
- Filtering apparatus with disposable 0.45 micron filters
- GPS unit
- Hand pump, peristaltic pump, vacuum pump, or equivalent equipment
- Oxidation-reduction potential meter
- Plastic HDPE sample pitcher
- Plastic squeeze bottle filled with distilled water
- Plastic trash bags
- pH/eH meter (with automatic temperature compensation)
- Rope if obtaining deep samples
- Rite-in-the-Rain™ field notebook
- Sample containers that are certified clean
- Sample labels
- Specific conductivity meter
- Strapping and clear tape
- Swing sampler
- Kemmerer or Van Dorn horizontal water bottle sampler
- Suitable HDPE 5 L container
- Turbidity meter
- Silicon tubing
- Wooden stakes
- Writing instruments
- Measuring tape

The governing workplan or SAP may require the use of other equipment based on the scope and objective of an individual project. Project personnel will review the workplan or SAP for any equipment not listed in this SOP.

4.7 Field Quality Assurance/Quality Control Samples

Field QA/QC sample requirements shall be as specified in the governing workplan or SAP.

4.8 Sample Containers

All sample bottles must be properly cleaned and prepared. Coordinate with selected analytical laboratory for appropriate sample bottle types and preparation requirements. Plastic, such as PVC, polyethylene, polypropylene, and Tygon, is an acceptable material for contacting samples when the analyses are for inorganic analytes (metals, radionuclides, anions, and cations). Stainless steel and fluorocarbon resin (Teflon, PTFE, FEP, HDPE, or PFA) are acceptable materials that may contact surface water samples. Glass is an acceptable material for contacting samples except when silica or fluoride analyses are to be performed.

4.9 Sample Handling

Sample handling procedures and chain of custody requirements shall be as specified in the governing workplan or SAP. Typical handling procedures for surface water samples are as follows:

- Store sample containers in coolers for transportation in compliance with the sample handling and chain of custody requirements specified in the workplan or SAP.
- Sample documentation and labeling requirements shall be as specified in the governing workplan or SAP.

All surface water samples shall be labeled and sealed and immediately placed in ice-filled coolers with securely closed lids for storage and transport. The analytical laboratory must receive samples in sufficient time to conduct the requested analyses within the specified holding time.

During surface water sampling operations, the proper personal protective equipment will be worn, as described in the applicable workplan or site safety and health plan, to minimize cross-contamination and to ensure the safety of the field sampling personnel.

SURFACE WATER SAMPLE COLLECTION FORM

Project: _____

Project Number: _____

Date: ____/____/____

Time: _____

Field Personnel: _____

Signatures: _____

SITE DESCRIPTION

Site Location: _____

Elevation _____

Station Number: _____

Photo No.: _____

Roll No.: _____

GPS Coordinates: Latitude ____° ____' ____" Longitude ____° ____' ____"

Comments/Descriptions: _____

FIELD DESCRIPTION

Sample Identification Number: _____

Surface Water Characteristics (color, odor, appearance): _____

Collection Method: Grab, Kemmerer _____

Field Measurements

Parameter	Reading/Measurement			Initials	Remarks
	Sample 1	Sample 2	Sample 3		
Air Temperature (°C or F)					
Specific Conductivity (mhos) @ 25° C					
Conductivity					
Dissolved Oxygen (mg/L)					
pH					
Oxidation-Reduction Potential (ORP)					
Turbidity (FTU)					
Water Temperature (°C)					

SOP-NW-9.2a

Surface Water Flow Measurements Using Man-Portable Devices or Estimation Techniques

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1.0 SCOPE

This Standard Operating Procedure (SOP) provides general techniques for obtaining valid, representative flow measurements from natural open-channels using estimation techniques or man-portable devices. Direct methods for flow measurements in open channels using weirs, flumes, or other devices and direct and indirect flow measurements in pipes are provided in SOP-NW-9.2, *Surface Water Flow Measurements*. This SOP applies to any work performed by MWH or subcontractor personnel for any portion of stream flow measurements and is intended to be used in conjunction with governing work plans or sampling and analysis plans (SAPs). Modifications to this SOP may be made with the approved by the Project Manager or Task Leader and the Quality Assurance (QA) Manager.

Stream flow measurement methods in this SOP assume the following conditions:

- No control structures will be used for flow measurements at surface water stations;
- A current meter will be the preferred method for discharge measurements; and
- A few locations may be appropriate for engineering estimates or volumetric measurement.

2.0 DEFINITIONS

Discharge is defined as the volume rate of flow of water, expressed in cubic feet per second (cfs), including any substances suspended or dissolved in the water. Methods for measuring discharge are based on a variety of flow conditions. Many discharge measurement methods are required because flow conditions differ from site to site.

3.0 RESPONSIBILITIES

3.1 Field Sampling Engineer

The Field Sampling Engineer is responsible for field testing, total and accurate completion of data sheets, and delivery of data to the Project Manager and designated project secretary, all as described in this technical procedure. All staff are responsible for reporting deviations or nonconformance of the procedure to the Field Team Leader, Project Manager, or Quality Assurance (QA) Manager, in compliance with the governing workplan or SAP requirements.

3.2 Field Team Leader

The Field Team Leader is responsible for supervising the Field Sampling Engineers. Supervision

includes ensuring that stream flows are measured as specified in project work documents and this technical procedure.

3.3 Project Manager

The Project Manager has overall management responsibilities for the project, is responsible for designing the sampling program, for arranging the logistics of the program, and for providing any required clarifications in the use of this procedure. The Project Manager may assume the responsibilities of the Field Team Leader on smaller projects.

The Project Manager is also responsible for maintaining project files and filing project documents, project correspondence, chain of custody forms, surface water flow measurement forms, generated data, and other associated and pertinent project information.

3.4 QA Manager

The QA Manager is responsible for developing and managing procedures outlined in the SOPs and in site specific SAPs, QA plans, and/or work plans.

4.0 DISCUSSION

The methods described by this procedure may be used to measure flow in open channels. Methods should be selected at the discretion of the Field Team Leader or Project Manager in accordance with any specific provisions of governing SAPs, QA plans, and/or work plans.

Because of the dynamic nature of surface water behavior, flow measurement by the methods described in this document may, on occasion, be impossible at some sites. It is understood that if unmeasurable flow conditions are encountered at any of the surface water data collection sites which are to be measured in this program, the field team will attempt to measure flow at a point upstream or downstream of the site and will note this point relative to the marked data collection point in the field logbook. Whether or not a measurement is made, the team will note the conditions that inhibited accurate flow measurement. This situation will be brought to the attention of the MWH Project Manager and QA Manager using the field change protocol established in the governing workplan or SAP.

5.0 PROCEDURES

5.1 Velocity-Area Method

Surface flow in stream channels that are greater than one foot wide, or where flow is estimated to exceed 2.0 cfs, will be measured by using the traditional stream gaging technique, the velocity-area method.

When using the velocity-area method to perform discharge measurements of flowing surface water streams, a current meter will be used. The most common current meters are vertical axis meters, such as the Price meter Type AA, and horizontal axis or propeller-type meters. The standard Price meter has a rotor 5 inches in diameter and 2 inches high with six cone-shaped cups mounted on a stainless steel shaft. A pivot bearing supports the rotor shaft. In addition to the type AA meters, a Price pygmy meter is used in shallow depths. The pygmy meter is scaled two-fifths as large as the standard meter and has no tailpiece. Propeller-type current meters employ a propeller turning about a horizontal axis. Variable flow conditions may require the use of the pygmy meter, the Price AA meter, or a propeller-type meter, depending on the amount of runoff contributing to streamflow.

5.1.1 Theoretical Considerations

The volume rate of flow of water, which is commonly called discharge (Q), is the product of multiplying the average velocity (V) times the total cross-sectional area (A):

$$Q = V * A$$

The current meter measures velocity at a point. The velocity-area method of making discharge measurements at a cross-section requires measurement of the mean velocity in multiple portions of the cross-section at each of the selected verticals. These are taken at subsections of the cross-section. A complete discussion of area-velocity methods is found in *Measurement and Computation of Streamflow: Volume 1 - Measurement of Stage and Discharge* (Rantz, 1982)

By dividing the stream width into subsections, total discharge becomes the total of discharges measured in each subsection. Velocity (v) is estimated using the two-point method, or for shallow streams, the six-tenths-depth method, measured at each subsection. The two-point method consists of measuring the velocity at 0.2 and then at 0.8 of the depth from the water surface, and using the average of the two measurements. For streams shallower than 2 feet, the six-tenths-depth method will be used. The six-tenths-method consists of measuring the velocity at 0.6 of the depth from the water surface.

Discharge becomes the sum of the products of each point velocity and cross-sectional area of each subsection:

$$Q = \Sigma (v * a)$$

where:

- Q = total discharge (in cubic feet per second),
- v = point velocity (feet per second), and,
- a = area of the subsection (square feet).

In measuring discharges for developing stream ratings for litigation and flood-plain insurance purposes, federal agencies typically base the number of subsections on the criterion that each subsection contain no more than 5 percent of the total discharge. While this method has reportedly resulted in measurement accuracy as high as 98 percent, factors such as the characteristics of the measurement section reduce this accuracy. Furthermore, measurements limiting flow to 5 percent of the total discharge are time-consuming. Therefore, in the interests of conserving time while maximizing measurement accuracy, current-meter measurements performed in channelized streams will be based on selecting subsections to contain approximately 10 percent or slightly more of the total discharge. However, the stream should not be partitioned into sections that are significantly greater than 10 percent of the total stream flow because individual measurements that may be in error will then have a significant impact on the overall average velocity determination.

In general, depending on average depth and velocity distribution, a stream less than 2 feet wide will require no more than 8 to 10 subsections. A stream up to 4 feet wide will require about 10 to 12 subsections. Streams wider than 4 feet will require more subsections. Further, subsections need not be of identical width. For example, because velocities near banks are generally lower than velocities near the center of streams, these subsections may be wider than subsections near the center. Subsections will also be more closely spaced if a stream has an unusually deep portion in the cross-section, or if velocities are higher than usual for the cross-section.

Velocity will be observed by current meter at each point for a period that ranges from 40 to 70 seconds.

The stage of a stream is the height of the water surface above an established datum plane. The water-surface elevation referred to is an arbitrary gage datum called the "gage height." Stage or gage height is to be measured and recorded in feet and tenths of a foot.

5.1.2 Required Measurement Conditions

In order to make a velocity-area discharge measurement using a flowmeter, the following conditions are required:

- The stream must be channelized: that is, observable banks must channel the stream flow;
- Depth must be greater than 0.2 foot across most of the cross-section being measured;
and
- The stream must have measurable velocity of at least 0.2 feet per second in most of the

cross-section, although the pygmy meter is capable of measuring velocity as low as 0.070 feet per second.

The first two conditions can often be met in streams of very low discharge by conservatively modifying the stream channel to produce a narrower and slightly deeper cross-section in order to meet measurement requirements. These modifications will include removal of aquatic growth or ice, moving large stones which impact velocity upstream or downstream of the cross-section, and narrowing or deepening of the cross-section. By rearranging small amounts of native rock or sand, the technician will produce a measurable cross-section. When such modifications are made, great care will be exercised to avoid unnecessary movement of sediments or the splashing of sediments or water onto field team members. After clearing the cross-section, flow will be allowed to stabilize before the current-meter measurement of velocities begins.

If depths of 0.2 feet or greater cannot be found or made, the velocity will be estimated by recording the time required for a floating object to cover a known length of the stream. The object velocity will be calculated by multiplying the fixed distance with the average stream area and a correction factor of .9 and dividing by the recorded time. At a minimum, three separate trials will be completed and a mean object velocity calculated.

Current meter measurements are best made by wading, if conditions permit. The Price AA, Pygmy, or propeller-type meters are used for wading measurements. Vertical axis current meters do not register velocities accurately when placed close to a vertical wall. A Price meter held close to a right-bank vertical wall will under-register because the slower water velocity near the wall strikes the effective (concave) face of the cups. The converse is true at a left-bank vertical wall. (The terms "left-bank" and "right-bank" designate direction from the center of a stream for an observer facing downstream). The Price meter also tends to under-register when positioned close to the water surface or close to the streambed.

5.1.3 Equipment

Current meters, timers, depth and width measuring devices, and a means of counting meter revolutions are needed for measurement of discharge. The equipment includes:

- Depth-measuring device
- Current meter
- Width-measuring devices, either engineer's tape or tagline
- Stopwatch
- Marker

Depth-Measuring Device. The depth-measuring device may consist of a graduated rod or staff in feet

and tenths. If a Price-type meter is used, the depth-measuring device will be the topsetting 2-inch diameter hexagonal wading rod.

Current Meter. A current meter is an instrument used to measure the velocity of flowing water. The principle of operation is based on the proportionality between the velocity of the water and the resulting angular velocity of the meter's rotor. By placing the current meter at a point in a stream and counting the number of revolutions of the rotor during a measured interval of time, the velocity of water at that point is determined.

Engineer's Tape or Tagline. Steel tapes, metallic tapes, or premarked taglines are used for width determinations during discharge measurements made by wading. Direct measurement of width using tapes or taglines can be accurate with proper precautions. Orientation normal to the flow pattern of the river and elimination of most of the sag, through support or tension, are recommended for improved accuracy.

Stopwatch. A stopwatch is used to measure time during which velocity is measured at each point in the cross-section. Velocity at each point is measured for a period greater than or equal to 40 seconds and less than or equal to 70 seconds.

Marker. Each location where the velocity-area method will be consistently applied will be marked with a field stake.

If a Price meter is used, additional equipment includes a headset. A headset attaches to an electronic connection at the upper end of the wading rod.

5.1.4 Maintenance and Calibration Procedures

Prior to use of the current meter and following use of the meter, tests will be conducted to ensure that the unit performs acceptably. For Price-type and propeller-type meters, calibration tests will be conducted prior to and after fieldwork. Calibration tests will be conducted in streams fitted with Parshall flume or equivalent measurement device. Stream velocities derived from flume readings will be compared to the meter readings.

In addition, for Price-type meters, spin tests will be conducted. The spin test will be performed in an enclosed area, such as in the cab of a truck or in the enclosed rear of a truck, to prevent wind interference. The test is to be performed prior to attaching the current meter to the wading rod. While holding the meter steady in an area sheltered from breezes, the technician will spin the rotor and then press the start button on the stopwatch. The technician will observe the meter until the rotor ceases to spin. The duration of the spin for the pygmy meter should be more than 40 seconds and for the Price AA meter should be more than 90 seconds. If the meter fails to meet the time-of-spin criteria, the meter

will be cleaned and oiled before use. If the meter continues to spin well beyond these time limits, the record will indicate that the meter spun for 40+ seconds, in the case of the pygmy meter, or for 90+ seconds, in the case of the Price AA meter.

To ensure reliable observations of velocity, it is necessary that the selected current meter be kept in good condition. Before and after each discharge measurement, meter cups, vanes, or propellers, pivot and bearing, and shaft should be examined for damage, wear, or faulty alignment. During measurements, the meter will be observed periodically when it is out of the water to be sure that the rotor or propeller spins freely.

Meters will be cleaned and, if applicable, oiled daily when in use. If measurements are made in sediment-laden water, the meter will be cleaned immediately after each measurement. After cleaning and lubrication, the rotor or propeller will be spun to make sure that it operates freely. If the rotor or propeller stops abruptly, the cause of the trouble will be sought and corrected before using the meter.

In addition to meter maintenance, the entire meter unit will be checked before departure to the field each day as follows:

- For Price-type meters, attach the current meter and digital counter/headset to the wading rod. Test the headset by:
 1. Spinning the current meter to ensure that audible clicks occur.
 2. If audible clicks do not occur, the following steps should correct the problem:
 - Check that electronic connections are tight;
 - Check that the cat's whisker lightly contacts the upper part of the shaft;
 - Spin again and if audible clicks still do not occur, check that the battery in the headset is properly aligned. Replace the battery, if necessary.
- For propeller-type meters, activate the sensor and test by:
 1. Moving the propeller through the air to ensure that electronic readings are displayed.
 2. If no display is visible, the following steps should be completed:
 - Check that the batteries have power. Replace if necessary;
 - Check that sensor and display are connected to the shaft wire.

5.1.5 General Considerations

Based on approximate depths, either the Price-type or propeller-type meter will be used to perform a velocity-area measurement. If depths or velocities under natural conditions are too low for a dependable current meter measurement, the cross-section will be modified, if practical, to provide acceptable conditions. A shovel will be used to remove aquatic vegetation, ice, or rocks that may interfere with meter operation or discharge measurement.

At each measurement point (or station) across the stream cross-section, depth is measured prior to measurement of velocity. Therefore, it is recommended that the measuring rod be set with the current meter suspended out of the water and above the tagline, which is used to measure width and to identify stations across the cross-section. Placement of the rod about 0.5 feet downstream from the tagline prevents contact between the tagline and the current meter when the meter is lowered into measuring position. The measuring rod will be placed in the stream so the base rests on the streambed, and the depth of water will then be read from the graduated main rod. The main rod is graduated into 0.1-foot increments.

The meter operator reads water depth directly from the depth-measuring rod. In high velocity areas, it is recommended that depth be read as the value between the depth on the upstream side of the rod and the depth on the downstream side of the rod. Depth is measured to the nearest 0.02 foot. This depth is used to set the vertical location on the current meter.

The meter operator will stand in a position that least affects the velocity of the water passing the current meter. The meter operator will face upstream while holding the depth-measuring rod vertically and close to the tagline or measuring tape. The meter operator stands at about a 45-degree angle downstream from the measuring rod and at least 1.5 feet from the depth-measuring rod. This angle is an imaginary angle between the extended arm holding the depth-measuring rod and the tagline or measuring tape. The meter operator should avoid standing in the water if his or her feet and legs occupy a significantly large percentage of a narrow cross-section. For narrow streams, it is often possible to stand astride the stream.

The depth-measuring rod should be held in a vertical position with the meter parallel to the direction of flow while the velocity is being observed. When measuring streams that have shifting beds, the soundings or velocities can be affected by the scoured depressions left by the hydrographer's feet. For such streams, the meter should be placed ahead of and upstream from the operator's feet.

5.1.6 Discharge Calculations

A stream discharge is the summation of the products of the subsection areas of the stream cross-section and their respective average velocities. The formula $Q = \Sigma (v * a)$ represents the computation, where Q is the total discharge, a is an individual subsection's area, and v is the corresponding mean velocity of

flow normal to the subsection. The summation of the discharges for all the subsections is the total discharge of the stream. The order for calculating discharge is:

- Use the distances from initial point to compute width for each section. The first width is computed by subtracting the first distance from the second distance, and dividing this quantity by two. The second width will be the quantity of difference between the third distance and the first distance, divided by two. For each subsequent width, subtract the distance on the line above the line you are calculating from the distance on the line below the line you are calculating, and divide this quantity by two. This procedure is carried out for each line until you reach the final width calculation. This is calculated as the quantity of the difference between the final distance and the second-to-the-last distance, divided by two.
- Subsequent calculations will be performed as follows:
 - Calculate each discharge for each subsection by multiplying the width of the subsection times the depth times the velocity.
 - Sum the discharges for each subsection to arrive at total discharge for the entire cross-section.
- Check your math by summing the subsection widths. Their total should equal the value obtained by taking the difference between the left and right bank station distances from initial point.
- Initial at the line "Comp. by" to identify yourself as the person responsible for performing the discharge calculation.

5.2 VOLUMETRIC METHOD

The volumetric method is a simple and accurate method for measuring flow from small discharges such as gravity flow discharges from pipe outlets.

5.2.1 Theoretical Considerations

This method involves measuring the time required to fill a container of known capacity, or the time required to partly fill a calibrated container to a known volume. Alternatively, in the case of measuring discharge remotely in a sump or standpipe setting, the volumetric method may be performed by capturing flow in a container for a set period of time. This volume of water is then measured and discharge is determined.

5.2.2 Required Measurement Conditions

Conditions must be such that all discharge from an outlet can be captured in the volumetric container during the period of measurement.

5.2.3 Equipment

The bucket and stopwatch technique is particularly useful for the measurement of small flows. Equipment required to make this measurement is a calibrated container and a stopwatch. Calibrated containers of varying sizes will include:

- 5-gallon bucket
- 2-liter graduated cylinder
- 1-liter graduated cylinder
- 1-liter bucket
- 500-milliliter beaker
- 250-milliliter beaker

5.2.4 Maintenance and Calibration Procedures

Graduated cylinders are incremented in terms of milliliters and can be easily converted to gallons. The incremental volume of a 5-gallon bucket can be determined by adding known volumes of water and recording the depth after each addition.

5.2.5 General Considerations

Upon arrival at the site, the sampling personnel will evaluate the flow conditions to select the appropriate method for flow measurement. If flow conditions are appropriate for volumetric measurement, the sampling personnel will observe and use judgment in approximating the flow volume and will select an appropriately sized volumetric container.

Sampling personnel will use a stopwatch to measure the time required to fill a volumetric container. The sampler will time flow into the container for a minimum of 10 seconds. Three consecutive measurements will be made and noted, and the results will be averaged to determine the discharge.

5.2.6 Discharge Calculations

Discharge will be determined initially in gallons per second (gal/s) or in milliliters per second (ml/s).

These values will be noted, but the average value will be reported in cubic feet per second. Calculations will be performed as follows:

- Record each of the three measurements in terms of gallons per second or milliliters per second, depending on the volumetric container.
- If one of the three measurements is 50 percent or more different from the other two measurements, then this value will not be used. Instead, three additional measurements will be taken and, provided that none of these three measurements differs by greater than 50 percent from the other two measurements, these values will be used.
- Average the three values.
- Convert the averaged value to cfs as follows:
 - To convert ml/s to cfs, multiply by 3.5×10^{-5}
 - To convert gal/s to cfs, multiply by 0.134
- Record discharge in cfs.

6.0 REFERENCES

Linsley R.K, Kohler, M.A., Paulhus, J.L.H. 1982. *Hydrology for Engineers*. McGraw-Hill Book Company. New York, N.Y.

Rantz, S.E., et al. 1982. *Measurement and Computation of Streamflow: Volume 1; Measurement of Stage and Discharge*. Geological Survey Water-Supply Paper 2175. U.S. Government Printing Office. Washington, D.C.

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SOP-5

GROUNDWATER LEVEL DATA COLLECTION

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1.0 PURPOSE

The purpose of this technical procedure is to establish a uniform and consistent procedure for measuring water levels in wells, piezometers and boreholes.

The groundwater level measurement procedures presented in the following sections were developed using standard industry-accepted practices, as well as international organization and agency guidelines and standard practices. The same care must be exercised in implementing field investigations and sampling events that are exercised in planning the program design and analyzing samples in the laboratory. No analytical result is better than the sample from which it was obtained.

Specific organizations and agencies with guidelines and standard procedures that were used include:

- U.S. Environmental Protection Agency (EPA)
- State of Nevada (U.S.) Division of Environmental Protection (NDEP)
- American Society of Testing and Materials (ASTM)

2.0 DEFINITIONS

2.1 Electric Water Level Sounder (EWS)

An electronic water-level sounder (EWS) is an instrument for measuring water levels in wells, piezometers and boreholes. An EWS is essentially an open circuit involving an ammeter and battery mounted on a reel to which an insulated two-wire electric cord (calibrated by length) is wound. The circuit is closed, and a buzzer sounds when the electrodes on the probe are immersed in water. Depth to water is recorded at the depth where the buzzer sounds.

3.0 DISCUSSION

Measurement of static water levels may constitute a separate task or be performed in conjunction with groundwater sampling. Prior to any purge sampling activity at each monitor well, a water level measurement is required to be taken. Measurement of the static water level is important in determining the hydrogeologic characteristics of the groundwater system.

Prior to taking the EWS to the field, check that the EWS is functioning properly and that the batteries are in working order by turning instrument on and pushing the test button located on the side of the instrument. Also verify that the probe is functioning properly by submerging it in tap water. Both the audio and visual signals should function.

Decontaminate the probe and cord of the EWS using Alconox or equivalent non-phosphate detergent and distilled water. Rinse a minimum of three (3) times with distilled water. At a minimum decontaminate the probe and the length of reel you believe will be in the well plus an additional 3 meters.

The measurement will be referenced from the reference point marked on the top of the well casing; this is typically located on the north side of the casing. The measurement to the static water level in the well

will be to the nearest 0.01-foot interval. The measurement will be immediately repeated to verify the accuracy of the initial reading. The depth to water measurement will be compared in the field to previous measurements to verify that the measurement is reasonable. Record the depth to water level on the field logbook and Record of Water Level Readings form (see Appendix A). Other items to record include well identification number, casing diameter, vertical height of measuring point above ground surface, and time and date of measurement.

If depth to water is measured in an open borehole, note that the reference level is ground surface. Also note, especially if the ground is uneven, from which side of the borehole (i.e. north, etc.) the measurement was referenced.

In addition, it is good practice to periodically measure total well depth, since silt can build up and decrease the total depth of the well. Measure the total depth of the well following determination of static water level. If using the EWS to determine the depth of the well, make sure that the additional cable that will be submerged has been decontaminated and that the probe tip length is added to the total depth measured. Total well depth measurement also ensures that the well is in good condition to total depth.

4.0 EQUIPMENT AND MATERIAL

The following is a list of equipment that should be available in the field to perform water level measurements.

- Electric Water-level Sounder or Measuring Tape with a Wettable Surface
- Folding Rule
- Field logbook or field data sheet (see Record of Water Level Readings form, found in Appendix A)
- Data on Well Identification Number and Locations
- Spare Battery for Electric Water-level Meter
- Permanent, waterproof pens

5.0 PROCEDURES

- Record well identification number and measuring device type and serial number.
- Each water level sounder or measuring tape used for recording water levels should have the depth graduations checked with an independent folding rule or measuring tape for calibration prior to field use.
- Clean all downhole instruments and equipment before and after measurements between wells. Cleaning should be with a non-phosphate detergent rinse followed by a rinse with approved tap water, then rinse with organic free distilled or deionized water.

- Measure and record distance from ground level to top of casing or standpipe. Measure the vertical distance from the top of casing or standpipe to the point of the elevation survey mark (if different from top of casing or standpipe).
- If an EWS is used, turn on the EWS, check the battery, lower the wire into the borehole or standpipe and stop at the depth where the EWS meter indicates a repeatable, completed circuit. Record the length of the wire below the casing collar or top of the standpipe to the nearest 0.01-foot.
- If a measuring tape is used, lower the tape (with a weight attached) into the borehole. The tape must be lowered a sufficient depth into the well to ensure the wettable surface section of the tape is partially submerged. The total length of the tape within the well (from the top of casing or standpipe) and the length of the wetted surface to the submerged end of the tape will be recorded.
- Record date, time, well designation, measuring device and all measurements on a Record of Water Level Readings form (Appendix A), and bound logbook. The personnel making the measurement will initial or sign each measurement recorded. All water level measurement records will be maintained in the project records files.

6.0 REFERENCES

- American Society of Testing and Materials (ASTM). 1994. *Standards on Ground Water and Vadose Zone Investigations*. Second Edition. ASTM Committee D-18 on Soil and Rock. Philadelphia, Pa.
- American Society of Testing and Materials (ASTM), 1995. *ASTM Standards on Environmental Sampling*. PCN-03-418095-38, Philadelphia, Pa.
- U.S. Environmental Protection Agency (EPA), 1994. *Standard Operating Procedures for Field Sampling Activities, Version 2*. EPA Region VIII, Denver, Colorado.
- U.S. Environmental Protection Agency (EPA), 1995. *Standard Operating Procedures for Water Level and Non-Aqueous Phase Liquid (NAPL) Measurements in Boreholes and Monitoring Wells, Version 1*. EPA Region VIII, Denver, Colorado.

APPENDIX A
RECORD OF WATER LEVEL READINGS

RECORD OF WATER LEVEL READINGS		
Job No. _____	Project No. _____	Location _____

Job No. _____

Project No. _____

Location _____

[illegible]

STANDARD OPERATING PROCEDURE

**LOW STRESS PURGING AND SAMPLING PROCEDURE
FOR THE COLLECTION OF GROUNDWATER SAMPLES
FROM MONITORING WELLS**

(Based on EPA Region 1, Revision 2. July 30, 1996.)

1.0 INTRODUCTION

This standard operating procedure (SOP) is intended to serve as a reference for the proper equipment and techniques for collecting groundwater samples by low-stress sampling techniques. The purpose of this SOP is to enable the user to collect representative and defensible groundwater samples, and to plan the field sampling effort. The techniques presented will be followed whenever applicable, although site-specific conditions or project-specific requirements may warrant adjustments in methodology. This SOP is based on EPA Region 1, Low Stress Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, Revision 2, July 30, 1996, which is attached as Attachment A.

This SOP describes groundwater sample collection by low-stress sampling methods, only. All other groundwater sampling procedures will be performed in accordance with the Field Sampling Plan of the

MONITORING WELL LOW-STRESS SAMPLING

Monitoring wells can be sampled with bladder pumps using lower flow rates. Studies have shown that groundwater in the screened interval of a standard monitoring well can be representative of groundwater in the formation, even though stagnant water lies above in the casing. This occurs when flow is generally horizontal and naturally purges the screened interval. However, the insertion of a sampling device, such as a bailer or pump, can disrupt this equilibrium and cause mixing of the screened and cased interval waters. The mixture of stagnant and screened interval water can even be forced into the aquifer, resulting in chemical and microbiological effects that may affect data quality. Therefore, low-stress sampling techniques are most accurate using dedicated sampling devices that can be left in place within a monitoring well. Considerations also need to be made for switching between standard purge volume and low-stress sampling methods.

The objective of low-stress sampling is to minimize the velocity/stress on the sample water as it exits the formation into the screened interval of the well and as it enters the

pump. Flow rates from 0.1 to 0.5 liter/minute (l/min) are typical for this sampling procedure. When performed correctly, water sampled using the low-stress technique is produced from the screened interval without disturbing stagnant water in the well casing. By using low flow rates to stabilize drawdown at less than the goal of 0.30 feet, only screened interval water will be sampled. Depth to water measurements during purging are recorded to verify that less than 0.3 feet of drawdown has occurred. In those cases where drawdown is observed to be greater than 0.3 feet, the pumping rate will be reduced by decreasing the pumping rate. If the pumping rate is reduced to less than 0.25 liters per minute and the drawdown still exceeds 0.3 feet after two 2-minute intervals, pumping will be halted. Project-specific work plans should be developed in cases where low-stress sampling with less than 0.30 feet of drawdown can not be achieved. Under these cases, the Project Manager must approve of alternative sampling methods prior to sampling. If drawdown is ever observed to be greater than 0.5 feet, pumping will be halted and the well will be allowed to recover before resuming low-stress sampling or purging at a lower pumping rate.

The following procedures will be used while performing low-stress purging and sampling:

1. Install a bladder pump in the well (if one does not already exist). Slowly lower the bladder pump into the well to minimize disturbance of the stagnant water within the well. Place the pump inlet in the screened interval at the appropriate depth, which should be near the midpoint of the screened interval unless site-specific conditions dictate placing the pump at a different point within the screened interval. Wait at least 48 hours after pump installation before purging and sampling.
2. Before initiating purging, place an electric water level indicator down to the top of the static water table and record the depth to groundwater.
3. Begin purging groundwater at a rate between 100 to 500 ml/min, making sure to minimize drawdown to less than 0.3 feet as a goal. Rates up to approximately 1 l/min may be feasible in high hydraulic conductivity formations, only if the

drawdown continues to be less than 0.3 feet. Measure drawdown at intervals of five minutes or less during purging. Adjust the purge rate to balance the desired (low) purge rate and water level drawdown. If the recharge to the well is less than 100 ml/min (i.e., excessive drawdown is occurring), proceed to Step 6.

4. The minimum volume to be purged from the well is two times the volume of the tubing and pump (available from the manufacturer). The tubing volume will be determined by multiplying the volume per foot of tubing (available from the manufacturer) by the total length of tubing.
5. During purging, measure the following groundwater quality parameters: pH, temperature, electrical conductivity, turbidity, DO, and ORP. The parameters will be considered stable when three consecutive readings, collected at intervals of at least five minutes, are within:

Conductivity	±10%
pH	±0.2 units
Temperature	±1 degree Celsius
Dissolved Oxygen	±0.2 mg/l
ORP	±10 millivolts
Turbidity	<5 NTU.

However, if the turbidity is not ≤ 5 NTU, but is stable (within ± 10 percent between readings) within a four-hour period, and all other parameters are stable, the samples will be collected. Once the parameters have stabilized, collect the samples.

6. If the well produces water at an extremely slow rate and excessive drawdown is occurring (> 0.30 feet.), even at a pumping rate of 100 ml/min, low-stress procedures may not be the best sampling method for the well. It is recommended that the standard practice for sampling low-recharge rate wells using bladder pumps be followed.

ATTACHMENT A

LOW STRESS PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUNDWATER SAMPLES FROM MONITORING WELLS

(Based on EPA Region 1, Revision 2. July 30, 1996.)

U.S. ENVIRONMENTAL PROTECTION AGENCY REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS



**July 30, 1996
Revision 2**

**U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I**

**LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE
FOR THE COLLECTION OF GROUND WATER SAMPLES
FROM MONITORING WELLS**

I. SCOPE & APPLICATION

This standard operating procedure (SOP) provides a general framework for collecting ground water samples that are indicative of mobile organic and inorganic loads at ambient flow conditions (both the dissolved fraction and the fraction associated with mobile particulates). The SOP emphasizes the need to minimize stress by low water-level drawdowns, and low pumping rates (usually less than 1 liter/min) in order to collect samples with minimal alterations to water chemistry. This SOP is aimed primarily at sampling monitoring wells that can accept a submersible pump and have a screen, or open interval length of 10 feet or less (this is the most common situation). However, this procedure is flexible and can be used in a variety of well construction and ground-water yield situations. Samples thus obtained are suitable for analyses of ground water contaminants (volatile and semi-volatile organic analytes, pesticides, PCBs, metals and other inorganics), or other naturally occurring analytes.

This procedure does not address the collection of samples from wells containing light or dense non-aqueous phase liquids (LNAPLs and DNAPLs). For this the reader may wish to check: Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation; C.K. Smoley (CRC Press), Boca Raton, Florida and U.S. Environmental Protection Agency, 1992, RCRA Ground-Water Monitoring: Draft Technical Guidance; Washington, DC (EPA/530-R-93-001).

The screen, or open interval of the monitoring well should be optimally located (both laterally and vertically) to intercept existing contaminant plume(s) or along flowpaths of potential contaminant releases. It is presumed that the analytes of interest move (or potentially move) primarily through the more permeable zones within the screen, or open interval.

Use of trademark names does not imply endorsement by U.S.EPA but is intended only to assist in identification of a specific type of device.

Proper well construction and development cannot be overemphasized, since the use of installation techniques that are appropriate to the hydrogeologic setting often prevents "problem well" situations from occurring. It is also recommended that as part of development or redevelopment the well should be tested to determine the appropriate pumping rate to obtain stabilization of field indicator parameters with minimal drawdown in shortest amount of time. With this information field crews can then conduct purging and sampling in a more expeditious manner.

The mid-point of the saturated screen length (which should not exceed 10 feet) is used by convention as the location of the pump intake. However, significant chemical or permeability contrast(s) within the screen may require additional field work to determine the optimum vertical location(s) for the intake, and appropriate pumping rate(s) for purging and sampling more localized target zone(s). Primary flow zones (high(er) permeability and/or high(er) chemical concentrations) should be identified in wells with screen lengths longer than 10 feet, or in wells with open boreholes in bedrock. Targeting these zones for water sampling will help insure that the low stress procedure will not underestimate contaminant concentrations. The Sampling and Analysis Plan must provide clear instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the remaining criteria in this procedure are met. If after 4 hours of purging indicator field parameters have not stabilized, one of 3 optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization) c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may not meet the sampling objectives).

Changes to this SOP should be proposed and discussed when the site Sampling and Analysis Plan is submitted for approval. Subsequent requests for modifications of an approved plan must include adequate technical justification for proposed changes. All changes and modifications must be approved before implementation in field.

II. EQUIPMENT

A. Extraction device

Adjustable rate, submersible pumps are preferred (for example, centrifugal or bladder pump constructed of stainless steel or

Teflon).

Adjustable rate, peristaltic pumps (suction) may be used with caution. Note that EPA guidance states: "Suction pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" (EPA/540/P-87/001, 1987, page 8.5-11).

The use of inertial pumps is discouraged. These devices frequently cause greater disturbance during purging and sampling and are less easily controlled than the pumps listed above. This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

B. Tubing

Teflon or Teflon lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for inorganics analyses. However, these materials should be used with caution when sampling for organics. If these materials are used, the equipment blank (which includes the tubing) data must show that these materials do not add contaminants to the sample.

Stainless steel tubing may be used when sampling for VOCs, SVOCs, pesticides, and PCBs. However, it should be used with caution when sampling for metals.

The use of 1/4 inch or 3/8 inch (inner diameter) tubing is preferred. This will help ensure the tubing remains liquid filled when operating at very low pumping rates.

Pharmaceutical grade (Pharmed) tubing should be used for the section around the rotor head of a peristaltic pump, to minimize gaseous diffusion.

C. Water level measuring device(s), capable of measuring to 0.01 foot accuracy (electronic "tape", pressure transducer). Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level "tape" at the start and end of each record.

D. Flow measurement supplies (e.g., graduated cylinder and stop watch).

E. Interface probe, if needed.

F. Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate the samples.

G. Indicator field parameter monitoring instruments - pH, Eh, dissolved oxygen (DO), turbidity, specific conductance, and temperature. Use of a flow-through-cell is required when measuring all listed parameters, except turbidity. Standards to perform field calibration of instruments. Analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846. For Eh measurements, follow manufacturer's instructions.

H. Decontamination supplies (for example, non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.).

I. Logbook(s), and other forms (for example, well purging forms).

J. Sample Bottles.

K. Sample preservation supplies (as required by the analytical methods).

L. Sample tags or labels.

M. Well construction data, location map, field data from last sampling event.

N. Well keys.

O. Site specific Sample and Analysis Plan/Quality Assurance Project Plan.

P. PID or FID instrument (if appropriate) to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

III. PRELIMINARY SITE ACTIVITIES

Check well for security damage or evidence of tampering, record pertinent observations.

Lay out sheet of clean polyethylene for monitoring and sampling equipment.

Remove well cap and immediately measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field logbook.

If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook.

A synoptic water level measurement round should be performed (in the shortest possible time) before any purging and sampling activities begin. It is recommended that water level depth (to 0.01 ft.) and

total well depth (to 0.1 ft.) be measured the day before, in order to allow for re-settlement of any particulates in the water column. If measurement of total well depth is not made the day before, it should not be measured until after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe are usually not needed unless analytical data or field head space information signal a worsening situation. Note: procedures for collection of LNAPL and DNAPL samples are not addressed in this SOP.

IV. PURGING AND SAMPLING PROCEDURE

Sampling wells in order of increasing chemical concentrations (known or anticipated) is preferred.

1. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the midpoint of the zone to be sampled. The Sampling and Analysis Plan should specify the sampling depth, or provide criteria for selection of intake depth for each well (see Section I). If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well. Collection of turbid free water samples may be especially difficult if there is two feet or less of standing water in the well.

2. Measure Water Level

Before starting pump, measure water level. If recording pressure transducer is used-initialize starting condition.

3. Purge Well

3a. Initial Low Stress Sampling Event

Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check water level. Adjust pump speed until there is little or no water level drawdown (less than 0.3 feet). If the minimal drawdown that can be achieved exceeds 0.3 feet but remains stable, continue purging until indicator field parameters stabilize.

Monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (for example, 0.1 - 0.4 l/min) to ensure stabilization of indicator

parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. Do not allow the water level to fall to the intake level (if the static water level is above the well screen, avoid lowering the water level into the screen). The final purge volume must be greater than the stabilized drawdown volume plus the extraction tubing volume.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (bladder, peristaltic), and/or the use of dedicated equipment. If the recharge rate of the well is lower than extraction rate capabilities of currently manufactured pumps and the well is essentially dewatered during purging, then the well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples (ideally the intake should not be moved during this recovery period). Samples may then be collected even though the indicator field parameters have not stabilized.

3b. Subsequent Low Stress Sampling Events

After synoptic water level measurement round, check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). Perform purging operations as above.

4. Monitor Indicator Field Parameters

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, Eh, DO) every three to five minutes (or less frequently, if appropriate). Note: during the early phase of purging emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at three (3) to five (5) minute intervals, are within the following limits:

- turbidity (10% for values greater than 1 NTU),
- DO (10%),
- specific conductance (3%),
- temperature (3%),
- pH (± 0.1 unit),
- ORP/Eh (± 10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values

measured within the cell and may also cause an underestimation of turbidity values measured after the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities.

The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must be submerged in water at all times. If two flow-through-cells are used in series, the one containing the dissolved oxygen probe should come first (this parameter is most susceptible to error if air leaks into the system).

5. Collect Water Samples

Water samples for laboratory analyses must be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain sample).

VOC samples should be collected first and directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

During purging and sampling, the tubing should remain filled with water so as to minimize possible changes in water chemistry upon contact with the atmosphere. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use one of the following procedures to collect samples: (1) add clamp, connector (Teflon or stainless steel) or valve to constrict sampling end of tubing; (2) insert small diameter Teflon tubing into water filled portion of pump tubing allowing the end to protrude beyond the end of the pump tubing, collect sample from small diameter tubing; (3) collect non-VOC samples first, then increase flow rate slightly until the water completely fills the tubing, collect sample and record new drawdown, flow rate and new indicator field parameter values.

Add preservative, as required by analytical methods, to samples immediately after they are collected if the sample containers are not pre-preserved. Check analytical methods (e.g. EPA SW-846, water supply, etc.) for additional information on preservation. Check pH for all samples requiring pH adjustment to assure proper pH value. For VOC samples, this will require that a test sample be collected during purging to determine the amount of preservative that needs to be added to the sample containers prior to sampling.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter is required, and the filter

size (0.45 um is commonly used) should be based on the sampling objective. Pre-rinse the filter with approximately 25 - 50 ml of ground water prior to sample collection. Preserve filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in ground water for human health risk calculations.

Label each sample as collected. Samples requiring cooling (volatile organics, cyanide, etc.) will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

6. Post Sampling Activities

If recording pressure transducer is used, remeasure water level with tape.

After collection of the samples, the pump tubing may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth is optional after the initial low stress sampling event. However, it is recommended if the well has a "silting" problem or if confirmation of well identity is needed.

Secure the well.

V. DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well and following sampling of each subsequent well. Pumps will not be removed between purging and sampling operations. The pump and tubing (including support cable and electrical wires which are in contact with the well) will be decontaminated by one of the procedures listed below.

Procedure 1

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Flush with isopropyl alcohol (pesticide grade). If equipment blank data from the previous sampling event show that the level of contaminants is insignificant, then this step may be skipped.

Flush with distilled/deionized water. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

VI.FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the ground water samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples shall be collected for each batch of samples (a batch may not exceed 20 samples). Trip blanks are required for the VOC samples at a frequency of one set per VOC sample cooler.

Field duplicate.

Matrix spike.

Matrix spike duplicate.

Equipment blank.

Trip blank (VOCs).

Temperature blank (one per sample cooler).

Equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank will only include the pump in subsequent sampling rounds.

Collect samples in order from wells with lowest contaminant concentration to highest concentration. Collect equipment blanks after sampling from contaminated wells and not after background wells.

Field duplicates are collected to determine precision of sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

If split samples are to be collected, collect split for each analyte group in consecutive order (VOC original, VOC split, etc.). Split sample should be as identical as possible to original sample.

All monitoring instrumentation shall be operated in accordance with EPA analytical methods and manufacturer's operating instructions. EPA analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846 with exception of Eh, for which the manufacturer's instructions are to be followed. Instruments shall be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be re-calibrated so that all measurements fall within the calibration range. At the end of each day, check calibration to verify that instruments remained in calibration. Temperature measuring equipment, thermometers and thermistors, need not be calibrated to the above frequency. They should be checked for accuracy prior to field use according to EPA Methods and the manufacturer's instructions.

VII.FIELD LOGBOOK

A field log shall be kept to document all ground water field monitoring activities (see attached example matrix), and record all of the following:

Well identification.

Well depth, and measurement technique.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and

detection method.

Pumping rate, drawdown, indicator parameters values, and clock time, at the appropriate time intervals; calculated or measured total volume pumped.

Well sampling sequence and time of each sample collection.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analysis.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling equipment used, including trade names, model number, diameters, material composition, etc.

VIII. DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, and whatever field logbook information is needed to allow for a full evaluation of data useability.

SOP-NW-5.3

Collection of Groundwater Quality Samples

Note: This document is proprietary, revision controlled, and is intended strictly for use by MWH and its teaming partners or subcontractors in support of specific contractual responsibilities. Copying and further dissemination in any manner is not permitted without written authorization by the responsible MWH Project Manager, except as may be agreed upon by MWH and its clients in the terms and conditions of applicable contracts.

1.0 SCOPE

This technical procedure establishes methods for collecting groundwater samples for chemical analysis representative of aquifer water quality.

This technical procedure is designed to cover general techniques for obtaining valid, representative samples from groundwater monitoring wells. The scope is intended to provide guidance while preparing for and during actual field sampling activities. The specific methods to be used at each monitoring well are described in the applicable workplan or sampling analysis plan (SAP).

This technical procedure is applicable to all MWH personnel engaged in the collection of groundwater samples from wells for purposes of chemical analysis and are intended to be used in conjunction with a project-specific workplan or SAP.

2.0 DEFINITIONS

2.1 Dedicated Pump System

A dedicated pump system is a permanently installed device for removing water from a well. The system is not removed from the well and does not have the potential to become contaminated between uses.

2.2 Well Storage Volume

Well storage volume is defined as the volume of water enclosed by the well casing and screen gravel/sand pack under equilibrium conditions.

2.3 Bailer

A bailer is a tubular device, with a check-valve at the top and/or bottom, used for collecting and removing groundwater from wells. The three most common types of bailers are: Single check valve; double check valve; and “thief” or “messenger” samplers.

- A single check valve bailer will expose part of the sample to the atmosphere. The typical sample transfer occurs by inserting a tube into the bottom of the bailer, pushing up the check valve, which allows the water to be released into the sample container. If used for VOC sampling the bailer should have a sample cock or draft valve at or near the bottom of the sampler allowing withdrawal of the sample from the well below the exposed surface water. Otherwise, discard the first few inches of sample at the bottom of the bailer.
- The double check valve sampler allows for point source sampling at a specific depth. The liquid will pass through the sampler while it is descending until the desired depth is reached. Once retrieval of the sample commences, both check valves close simultaneously, thereby allowing the

specific depth to be sampled.

- The thief or messenger sampler also allows for point source sampling at a specific depth. A weighted messenger is dropped down the suspension line and closes the sampling vessel thus obtaining a sample at the desired depth.

To avoid potential sources of contamination, keep the bailer suspension lines off the ground and away from any other potentially contaminating sources to minimize the possibility of contaminants being carried down into the well. If needed, a decontaminated tarp or plastic bag is recommended for storage of the bailer suspension line.

2.4 Non-Dedicated Sampling Apparatus

A non-dedicated sampling apparatus is sampling equipment that is not used solely for collection of groundwater samples from a single well. This term is also used to describe equipment that is only used for sampling a single well, but is removed from the well and could potentially become contaminated.

2.5 Groundwater Sample

A groundwater sample is defined as water acquired from a well for chemical analyses that is representative of groundwater within the aquifer or the portion of the aquifer being sampled.

2.6 Positive Pressure Pump

A positive pressure pump is a device for removing water from a well by forcing water to the surface through positive pressure when operated below the water level in a well. A positive pressure pump may be operated electrically, mechanically, or by air/nitrogen pressure. Submersible impeller, bladder, and check valve pumps are common types of positive pressure pumps.

2.7 Suction Lift Pump

A suction lift pump is a device for removing water from well by negative pressure (suction). Direct line, peristaltic and centrifugal pumps are the three types of suction lift pumps. The limitation for lifting water by suction is usually 20 to 25 feet. These pumps are only acceptable for non-volatile analytes and analytes that are not affected by aeration or changes in pH. They are useful as purging devices for shallow groundwater wells.

Peristaltic pumps are preferred when a suction lift pump is required. This is the only suction lift pump, of the three mentioned above, in which the liquid being sampled moves entirely within the sample tubing. The groundwater sample never contacts the actual pump apparatus during sampling thus eliminating a possible source of sample contamination from the actual pump, lubricants, or parts.

Standard silicon tubing is the most commonly used sample tubing. Most pump manufacturers and rental companies offer acceptable tubing lined with TFE-fluorocarbons or Viton. The National Council of the Paper Industry for Air and Stream Improvement recommends medical grade silicon tubing for organic sampling;

however, it is limited to use over a restricted range of ambient temperatures. Standard silicon tubing uses an organic vulcanizing agent, which has been shown to leach into samples.

2.8 Sample Bottles

Sample bottles are containers specifically designed and prepared for storing liquid samples. Sample bottle type, material, size, and type of lid shall be as specified in the governing workplan or SAP. Sample bottles must be properly cleaned and prepared by a laboratory or the manufacturer in accordance with standard laboratory methods and procedures. Coordinate with selected analytical laboratory for bottle type and preparation requirements.

2.9 Acceptable Material

Acceptable materials are defined as pump systems that have minimal effect on water quality when used to obtain groundwater samples from wells. The use of pumps is dependent on the analyses being conducted on the acquired samples. The parts of pumps that will contact the groundwater sample contain only acceptable materials.

3.0 RESPONSIBILITIES

3.1 Field Sampling Engineer

The Field Sampling Engineer is responsible for sample collection, sample custody in the field, sample preservation, field testing, total and accurate completion of data sheets, sample shipment and delivery of data to the Project Manager and designated project secretary, all as described in this technical procedure.

3.2 Field Team Leader

The Field Team Leader is responsible for supervising the Field Sampling Engineers. Supervision includes ensuring that samples are collected, documented, preserved, field analyzed, handled and shipped to the appropriate laboratory as specified in project work documents and this technical procedure.

3.3 Project Manager

The Project Manager has overall management responsibilities for the project, is responsible for designing the sampling program, for arranging the logistics of the program, and for providing any required clarifications in the use of this procedure. The Project Manager may assume the responsibilities of the Task Leader on smaller projects.

The Project Manager is also responsible for maintaining project files and filing project documents, project correspondence, chain of custody forms, groundwater purging and sampling forms, generated data, and other associated and pertinent project information.

4.0 DISCUSSION

The following is a listing of general procedures that should be followed during every sampling event.

- Groundwater samples shall be collected in quantities and types as described in the governing workplan or SAP.
- Water level data collection (see MWH SOP-5 for appropriate procedure).
- Determination of well storage volume (see Section 5.2.1, below).
- All instruments used for field analyses should be calibrated in accordance with the manufacturer's instructions.
- All non-dedicated sampling equipment shall be decontaminated before and after each use.
- If so directed by the governing workplan or SAP, purge water and decontamination fluids shall be captured and contained for disposal.
- Samples shall be collected in properly prepared containers of the appropriate size and type, and all samples shall be appropriately labeled and sealed, as required by the governing workplan or SAP.
- Samples shall be stored and transported in coolers chilled to 4° Celsius or less. Sample handling and chain of custody shall be as specified in the governing workplan or SAP.
- The Groundwater Purging and Sampling Form (see Appendix A) and the field log book shall be used to document daily site activities and sample collection.
- All variations from established procedure shall be documented on the Groundwater Purging and Sampling Form (see Appendix A) and shall be approved by the Project Manager prior to proceeding with the work variation.

PROCEDURE

5.1 General Considerations

5.1.1 Decontamination

All non-dedicated sampling equipment that may contact the sample must be decontaminated before and after

each use unless it is disposable and being used for only a single well. Non-dedicated pumps or bailers require decontamination of internal and external parts prior to being lowered into the well. Non-dedicated equipment shall first be washed with clean tap water (whose chemistry is known and acceptable), non-phosphate detergent, and rinsed with clean tap water. For inorganic analytes a weak hydrochloric acid (HCl) or nitric acid (HNO₃) solution shall be used for the second wash. For organic analytes, reagent-grade methanol shall be used for the second wash. A final rinse with organic-free distilled/deionized water shall complete the decontamination. At a minimum, all acid and methanol wash solutions must be captured (see Section 5.5.1, below).

5.1.2 Sample Quantities, Types, and Documentation

Samples shall be collected in quantities and types as specified in the governing workplan or SAP.

The Groundwater Purging and Sampling Form (Appendix A) and the field logbook shall be used to document daily site activities and sample collection (see Section 5.6, below). Samples shall be transferred to the analytical laboratory under formal chain of custody, which shall be documented and maintained in accordance with procedure.

5.1.3 Sample Containers

All sample bottles must be properly cleaned and prepared. Coordinate with selected analytical laboratory for appropriate sample bottle types and preparation requirements. All groundwater samples shall be labeled and sealed and immediately placed in coolers chilled to 4° Celsius or less with securely closed lids and custody seals on the outside of the cooler for storage and transport. Samples must be received by the analytical laboratory in sufficient time to conduct the requested analyses within the specified holding time.

5.1.4 Acceptable Materials

Stainless steel and fluorocarbon resin (Teflon, PTFE, FEP, or PFA) are acceptable materials that may contact groundwater samples. Glass is an acceptable material for contacting samples except when silica or fluoride analyses are to be performed. Plastics (PVC, polyethylene, polypropylene, tygon) are an acceptable material for contacting samples when the analyses are for inorganic analytes (metals, radionuclides, anions, cations).

5.1.5 Sample Acquisition

Groundwater samples shall be removed from the well with the use of a permissible pump or bailer. Electric positive-pressure pumps, as defined in Section 3.6, made of acceptable materials are permissible to use for acquiring any groundwater sample. Air/nitrogen pressure activated positive-pressure pumps made of acceptable materials are permissible to use for acquiring any groundwater sample if the air/nitrogen does not contact the sample. Positive-pressure pumps operated by mechanically forcing water through check valves are permissible for acquiring groundwater samples. Bailers made of acceptable materials are permissible for acquiring groundwater samples.

Peristaltic pumps and airlift pumps are not preferred for acquiring groundwater samples but are permissible when samples are to be analyzed for analytes that are not volatile, are not affected by aeration, and are not affected by changes in pH.

Other types of pumps (peristaltic, centrifugal, air lift, recirculation, etc.) may be used for purging groundwater from wells prior to sample acquisition, if: (1) pump materials contacting well water are acceptable; (2) pumping does not aerate or change the pH of the remaining well water; and (3) pumped water does not mix with remaining well water during pumping or after the pumping is stopped.

5.2 Equipment And Materials

If wells are equipped with dedicated pump systems, equipment to operate the dedicated pump systems (i.e., air compressor, compressed air or nitrogen cylinders, electric generator, etc.) as well as non-dedicated sampling apparatus, such as surface discharge tubing and valves, may be necessary.

If wells do not have permissible and dedicated pump systems, permissible pump systems or bailers and accessories of small enough diameter to enter the wells will be necessary. All equipment that could contact the sample shall be made of acceptable materials.

Sample bottles and preservatives appropriate for the parameters to be samples will be necessary. Coordinate with selected analytical laboratory for bottle type and preparation requirements.

Field test equipment necessary for groundwater sampling:

- Thermometer
- pH meter and standards
- Conductivity meter and standards
- dissolved oxygen meter (optional)
- turbidity meter and standards
- Filtration apparatus (0.45 micron), if necessary
- Depth to water measuring device
- Coolers and ice packs
- Organic-Free Distilled or deionized water
- Cleaning equipment (scrub brushes) and solutions (non-phosphate detergent)
- Indelible ink pens and felt-tip markers
- Sample labels and seals
- Container(s) for capturing, containing, treating and measuring waste decontamination solutions, if necessary.
- Well specifications
- Groundwater Purging and Sampling Forms (Appendix A)
- Field logbook
- Chain of Custody Forms (provided by selected laboratory)
- As required, 55 gallon steel drums fitted with bung holes, or suitable tank(s) for containing purged

- groundwater.
- Additional preservatives (i.e., HNO_3)
- Copy of this SOP, SOP-5 and the governing workplan or SAP.

5.3 Groundwater Sample Acquisition

5.3.1 Purging the Well

The pump or bailer shall be used and operated in accordance with the manufacturer's operational manual. Before collecting the actual groundwater sample, a minimum of three (3) well bore storage volumes of water shall be purged from the well by pumping unless low-flow sampling techniques are being employed. Calculate this volume by measuring the depth to water and subtracting this depth from the total depth of the well. If a gravel/sand pack surrounds the screen, the pore volume of the gravel/sand pack (assume a porosity of 25 percent if unknown) shall be added to the total well volume. While purging water from the well, the conductivity, pH, temperature, dissolved oxygen (optional) and turbidity of the water shall be periodically measured. If the conductivity (within 10%), pH (within 0.1 pH units), temperature (within 0.5 degrees Celsius), dissolved oxygen (within 10%) or turbidity (within 10% and less than 5 NTU) of the water has not stabilized when a minimum of three (3) well volumes have been purged, then continue to purge water until these parameters stabilize as specified above. If the parameters of interest in the investigation include VOCs, care must be taken to ensure that purging does not induce degassing within the well. Where the well screen and sand pack are completely below the water table, the rate of purging should be controlled such that it does not draw the water level in the well below the top of the well screen. Where the well screen and sand pack are intersected by the groundwater level, the rate of purging should correspond with the rate of sampling, if continuous sampling methods are used. Large drawdowns in water table wells should be avoided. Purged groundwater that has a reasonable potential of containing hazardous substances shall be captured and characterized prior to discharge or disposal (see Section 5.5.1, below). Record the time after each well volume has been purged in order to keep track of actual pumping rate.

5.3.2 Samples for Major Cation, Metal, and Metallic Radionuclide Analyses

Samples for major cation, metal, and metallic radionuclide analyses (including Se) shall be immediately filtered after acquisition. Filtration is best accomplished with the use of an in-line filter system in which the sample is directly fed from the discharge port of a positive-pressure pump through the filter and into the appropriate sample bottle. A less preferred but acceptable method is the collection of an adequate amount of sample from a permissible positive-pressure pump or bailer into a properly cleaned and prepared high-density linear polyethylene or glass bottle. Samples shall be immediately fed through the filter and collected directly into the appropriate sample bottle. The final filter pore size should be 0.45 micron. (Note: New filters shall be used for each sample, and the filter system must be decontaminated before and after each sample.) These groundwater samples shall be preserved after filtration with nitric acid (HNO_3) to a pH less than 2.

In addition, if toxic metal or priority pollutant metal analyses are to be performed, an unfiltered sample will also be obtained (in addition to the filtered sample) directly from a permissible positive-pressure pump discharge

port or from the bailer into appropriate sample bottles and preserved with nitric acid (HNO_3) to a pH less than 2. The only exception is analysis of chromium VI, in which case preservatives shall not be added to the sample.

5.3.3 Samples for Cyanide Analyses

Samples for cyanide analyses shall be collected directly into appropriate sample bottles from the bailer or the port of a positive-pressure pump. Samples shall not be filtered nor shall they be allowed to overflow the sample bottle. Samples shall be immediately preserved with sodium hydroxide (NaOH) to a pH greater than 12.

5.3.4 Samples for Major Anion and Biological Oxygen Demand (BOD) Analyses

Samples for major anions (chloride, fluoride, sulfate, alkalinity, acidity, total silica, bromide) and for biological oxygen demand shall be collected directly into appropriate sample bottles from the port of the pump or from the bailer. These samples do not require filtration, but may be filtered, if desired. Preservatives shall not be added.

5.3.5 Samples for Total Phosphate and Orthophosphate Analyses

Groundwater samples for total phosphate and orthophosphate analyses shall be immediately filtered after initial sample acquisition. Filtration is best accomplished with an in-line system in which a positive-pressure pump discharge port feeds groundwater directly through the filter system into an appropriate sample bottle. A less preferred but acceptable method is to collect a liter of sample from a positive-pressure pump or bailer in a properly cleaned and prepared high-density polyethylene or glass bottle, and then immediately feed the sample through a filter system which discharges into the appropriate sample bottle. The final filter pore size shall be 0.45 micron. (Note: New filters must be used for each sample and the filter system must be decontaminated before and after each use.) Samples shall be immediately preserved with sulfuric acid (H_2SO_4) to pH less than 2.

5.3.6 Samples for Nitrogen Compound, Chemical Oxygen Demand, Oil and Grease, and Total Organic Carbon Analyses

Groundwater samples for nitrogen compound, chemical oxygen demand, oil and grease, and total organic carbon analyses shall be collected directly into appropriate sample bottles from a permissible positive pressure pump discharge port or from the bailer. These samples shall not be filtered and shall be preserved with sulfuric acid (H_2SO_4) to a pH less than 2.

5.3.7 Samples for Analysis of Total Dissolved Solids

Groundwater samples for analyses of total dissolved solids shall be immediately filtered in the field by methods discussed in Section 5.3.3 above, and collected directly into an appropriate sample bottle. Samples shall not be preserved with additives.

5.4 Field Analyses

5.4.1 Calibration of Instruments

All instruments used for field analyses shall be calibrated prior to use and daily during use. Only equipment with a calibration tag showing a recall date later than the anticipated date of use shall be taken to the field. Each instrument should be accompanied by a copy of the manufacturer's operation manual.

5.4.2 Water Temperature

A pocket thermometer or other measuring device shall be used to measure the temperature of the water on an aliquot of purged water obtained just before or after sampling. The thermometer reading shall be allowed to stabilize and shall be recorded to the nearest 0.5 degree centigrade. The instrument shall be rinsed with distilled or deionized water before and after each use.

5.4.3 pH Measurement

A pH meter shall be used to measure the pH of the sample on sample of purged water that was obtained just before or after sampling. Measurements shall be made immediately on the obtained sample (note: if possible, measure pH continuously on the purged water in a closed flow-through system). Calibration shall be in accordance with the manufacturer's procedures (provided with the instrument). Calibration shall be performed with standardized buffered pH solutions bracketing the range of expected pH and conducted at the beginning and end of each day. Before and after each reading, the probe shall be thoroughly rinsed with distilled or deionized water. The pH shall be recorded to one-tenth (or one-hundredth if the meter is stable enough) of a pH unit.

5.4.4 Conductivity Measurement

A conductivity probe shall be used for conductivity measurement on an aliquot of purged water obtained just before or after sampling. Measurements shall be made as soon as possible on the obtained aliquot. The meter shall be calibrated in accordance with manufacturer's procedures (provided with the instrument) with standardized KCl solutions. At a minimum calibration shall be performed at the beginning and ending of each days use. The conductivity shall be recorded to two significant figures. The temperature of the sample at the time of conductivity measurement shall also be recorded. The probe must be thoroughly rinsed with distilled/deionized water before and after each use.

5.4.5 Dissolved Oxygen Measurement

A dissolved oxygen meter is used to measure dissolved oxygen (DO) in water samples. Measurements shall be made immediately on aliquots obtained just before or after sample acquisition. (Note: If possible, measure DO continuously on the purge water in a closed flow-through system). The meter shall be calibrated in accordance with the manufacturer's procedures (provided with the instrument) using distilled/deionized water that has been allowed to equilibrate with the atmosphere at a given elevation. The salinity adjust shall be adjusted to the

appropriate salinity of the water. Measure the temperature and concentration of dissolved oxygen in the sample while the salinity is on the fresh setting. The probe must be thoroughly rinsed with distilled or deionized water before and after each use. Measurements shall be recorded to the nearest 0.1 ppm concentration.

5.4.6 Turbidity Measurements

A turbidity meter shall be used to make turbidity measurements on aliquots of water samples obtained just before or after sample acquisition. Measurements shall be made as soon as possible on the obtained aliquot. Operation and calibration shall be in accordance with the manufacturer's procedures (provided with the instrument). Standardized solutions shall be used for calibration. The instrument shall be calibrated at least once during the purging and sampling of each well. The outside of the glass vials used for containing the aliquot for measurement must be wiped thoroughly dry before and after each use. Measurements shall be recorded to the nearest 0.1 NTU when less than 1 NTU; the nearest 1 NTU when between 1 and 10 NTU; and the nearest 10 NTU when between 10 and 100 NTU.

5.5 Capture And Disposal Of Purge Water And Decontamination Solutions

5.5.1 Purge Water

If specified in the applicable workplan or SAP, purged groundwater shall be captured and contained in 55 gallon steel drums or suitable tank(s). If so required, each drum or tank containing captured purge water shall be properly labeled with a weatherproof label as to the contents, the well(s) from which the contained purge water originated and the date in which the contents were generated. Storage of the drums or tanks shall be as specified in the project work documents or as directed by the Project Manager.

Captured and contained purge water shall be characterized for discharge, treatment and/or disposal. Characterization of the captured and contained purge water should be specified in the project work documents or by the Project Manager, but could rely on the analytical results of groundwater samples associated with each drum or tank, or could involve direct sampling and analyses of the contained water.

The requirements and options available for discharge, treatment and/or disposal are dependent upon many variables such as chemical consistency, local and state regulations, and location of site. Discharge, treatment, and/or disposal of captured and contained purge water must be in accordance with local, state and Federal regulations and shall be specified in the project work documents.

5.5.2 Decontamination Waste Solutions

Decontamination waste solutions that are generated during groundwater sampling include: spent detergent wash solutions; spent tap water rinses; any spent weak acid rinses, any spent methanol rinses; and spent final distilled/deionized water rinses. All spent acid and methanol rinses shall be captured and contained in plastic buckets or drums. Other spent decontamination waste solutions shall be captured and contained in appropriately sized buckets or drums if a reasonable potential exists for the spent solutions to contain hazardous

substances. Project work documents shall address, or the Project Manager shall determine, whether spent decontamination solution requires capture and containment.

Captured and contained decontamination waste solutions shall be subject to the same procedures as described for purge water. Some noteworthy differences are as follows: (1) all acid solutions shall be neutralized with lime prior to discharge or disposal; (2) methanol solutions may be able to be evaporated if segregated from other waste solutions, if generated in small enough quantities, and if conditions are favorable; and (3) if quantities are sufficiently small, decontamination waste solutions (detergent washes, rinse waters, neutralized acid solutions) may be added to the captured and contained purge water that corresponds to the same well sampling effort.

5.6 Documentation

Documentation for sampling groundwater includes labeling sample bottles, and completing Groundwater Purging and Sampling Forms, and Chain of Custody Records, and securing individual samples or sample coolers with chain of custody seals.

5.6.1 Sample Labels

Samples shall be immediately labeled. Labels shall be waterproof. Information shall be recorded on each label with indelible ink. All blanks shall be filled in (N/A if not applicable). Groundwater sample designations shall be as specified in the governing workplan or SAP.

5.6.2 Groundwater Purging and Sampling Forms

Groundwater Purging and Sampling Forms (Appendix A) shall be used by the Field Sampling Engineer to record daily activities. Data shall be recorded on the Groundwater Purging and Sampling Form in chronological format. The time of each recorded event shall be included. The original Groundwater Purging and Sampling Form shall be submitted as soon as possible to the Project Manager or Task Leader.

5.6.4 Field Log Book

The field logbook is used by the Field Sampling Engineer to document the official raw field information for each sample that will be chemically analyzed. The original must be submitted as soon as possible to the Project Manager or Task Leader.

5.6.5 Chain of Custody Records

Sampling handling and chain of custody protocols shall be as specified in the governing workplan or SAP. Chain of custody records will normally be used to record the custody and transfer of samples. Chain of custody forms are normally provided by the selected analytical laboratory. These forms shall be filled in completely (use N/A if not applicable). Tamper-proof seals shall be placed on either sample bottles or shipping coolers. The seal number shall be recorded on the Chain of Custody Form. The original form must accompany the samples to the analytical laboratory to be completed and returned to MWH for filing. A copy of the Chain of Custody

Record documenting the transfer of samples from the field shall be submitted to the Project Manager or Task Leader.

6.0 REFERENCES

- ASTM, 1995, ASTM Standards On Environmental Sampling - (PCN - 03-418095-38). ASTM, Philadelphia, PA.
- U.S. EPA, 1986, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document, U.S. EPA/ Office of Solid Waste, Washington D.C.
- U.S. EPA, 1986, Test Methods for Evaluating Solid Waste - (SW-846). U.S. EPA/Office of Solid Waste, Washington, D.C.
- Wood, W.W. (1976), Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents, Techniques of Water-Resources Investigations of the United states Geological Survey, Book 1, Collection of Water Data by Direct Measurement, Chapter D2.

APPENDIX A
GROUNDWATER PURGING AND SAMPLING FORM

GROUNDWATER PURGING AND SAMPLING FORM

Project No.: _____ Project Name: _____ Client: _____

Location: _____ Well No: _____

Date _____ Start Time _____ Weather _____

Depth to Water _____ Measuring Point _____

Water Column Height _____ Well Dia. _____

Sampling Method: Submersible Pump ☐ Centrifugal Pump ☐ Peristaltic Pump ☐ Other ☐
Bottom Valve Bailer ☐ Double Check Valve Bailer ☐ Stainless-Steel Kemmerer ☐

Criteria: 3 to 5 Casing Volumes of Water Removal ☐ Stabilization of Indicator Parameters ☐ Other _____

Gal/ft x ft of water	Water Volume in Well		Gal/oz to be removed
	Gallons	Ounces	

Time (military)	pH (su)	SC (umhos/cm)	Temp (°C)	ORP (millivolts)	D.O. (mg/L)	Turbidity (NTU)	Vol Evac. (gal.)	Comments/ Flow rate

Final: Time	pH	SC	Temp	Eh-ORP	D.O.	Turbidity	Ferrous Iron	Vol Evac.	Comments/Flow Rate

COMMENTS:

INSTRUMENTATION: pH Meter ☐ _____ Temperature Meter ☐ _____
DO Monitor ☐ _____ Other ☐ _____
Conductivity Meter _____

Water Disposal _____

Sample ID _____

Sample Date _____

Sample Time _____

APPENDIX B – COMMENTS AND COMMENT RESPOSE DOCUMENTS



STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

444 Hospital Way #300 • Pocatello, Idaho • 83201

C.L. "Butch" Otter, Governor
Toni Hardesty, Director

3 August 2009

Mr. Barry Koch
Special Projects Lead - Mining
P4 Production, LLC
PO Box 816
Soda Springs, ID 83276-0816

Re: *2009 Groundwater Monitoring Sampling and Analysis Plan, Revision 2, July 2009*

Dear Mr. Koch,

The Agencies and Tribes have reviewed the *2009 Groundwater Monitoring Sampling and Analysis Plan, Revision 2, July 2009*, submitted by P4/Monsanto pursuant to Consent Order/Administrative Order on Consent, EPA Docket No. CERCLA-10-2003-0117. With incorporation of the minor changes listed below the *2009 Groundwater Monitoring Sampling and Analysis Plan, Revision 2* is approved. Please provide pertinent pages (e.g., spine and cover sheets, title page) for incorporation into Revision 2 indicating the document is final. We will also need a new pdf file of the final document.

Please let me know if you have any questions. I can be reached at 208-236-6160 or electronically at michael.rowe@deq.idaho.gov.

Sincerely,

A handwritten signature in black ink that reads "Mike Rowe". The signature is written in a cursive, flowing style.

Mike Rowe
Regional Mining Project Manager

Enclosure

cc: Robert Geddes (P4/Monsanto)
Cary Foulk (MWH)
Doug Tanner, Bruce Olenick (IDEQ)
Jeff Jones, Mary Kauffman (C-TNF)
Jason Sturm (BLM)
Allen Ruberry (IDL)
Kelly Wright (Shoshone-Bannock Tribes)
Sandi Arena (USFWS)
Dave Tomten (EPA)
Bill Wiley (BIA)
File copy/Monsanto/Correspondence

Agencies and Tribes Comments on
2009 Groundwater Monitoring Sampling and Analysis Plan,
Revision 2, July 2009
3 August 2009

General Comments

None

Specific Comments

2-1. Table 2-1, page 2-5, Step 4, Temporal boundary. When explaining the decision factors for sampling in the fall, it might make sense, and would be more consistent, to use the new language found in Section 3.3.3, paragraph 1 on page 3-13.

Appendices

Field Sampling Plan

2-2. Table 4-1. Add other parameters to be analyzed such as gross alpha and gross beta, hardness, and total suspended solids.

Editorial Comments

Section 2.0, page 2-1, paragraph 3, line 3. Change *principle* to “principal.”

Table 2-1, page 2-5, Step 3, bullet 7. It appears that this bullet would be improved by insertion of a comma(s), such as “existing site characterization, groundwater quality sampling and analysis plans and procedures”.

Table 2-1, page 2-6, Step 4, Practical Constraints. Delete the comma and insert a closing parenthesis after *MDS034*.

Table 2-1, page 2-6, Step 5, Principal Study Question #3, line 2. Insert a comma for the last *and* to read “. . . groundwater and surface water, aid in review . . .”

Table 2-1, page 2-7, Step 7, line 2. Change *is* to “are.”

Section 3.3.2, page 3-11, bullet 5 (Dump seeps, springs, and streams), line 6. Change *bee* to “be.”

Section 3.3.3, page 3-13, paragraph 3 (last), line 4. Add a period after criteria and capitalize *these* to read “. . . groundwater quality criteria. These locations . . .”

Appendices

Field Sampling Plan

Table 4-3, page 4-8, column 2. Add “MWs” after *2008* to read “2008 MWs & MMW009”.

Table 4-5, pages 4-12 and 4-13. Change the title of the table to “. . . and 2009 Monitoring Wells”.

Table 4-5, page 4-12, column 6. To be consistent with Table 3-3 in the SAP and Table 4-3 in the FSP, add "Cr" in the column beginning *Total Cd*.

Table 4-5, page 4-12, column 7. To be consistent with Table 3-3 in the SAP and Table 4-3 in the FSP, add "Fe" in the column beginning *Total Al*.

Table 4-7, page 4-17, column 10. To be consistent with Table 3-3 in the SAP and Table 4-3 in the FSP, delete *K* and *Na* in the column beginning *Dissolved Ca*.

**Response to 3 August 2009 Agencies and Tribes Comments on the 2009
Groundwater Water Monitoring Sampling and Analysis Plan, Revision 2, 24 July 2009**

General Comments

None

Specific Comments

2-1. Table 2-1, page 2-5, Step 4, Temporal boundary. When explaining the decision factors for sampling in the fall, it might make sense, and would be more consistent, to use the new language found in Section 3.3.3, paragraph 1 on page 3-13.

Response: *Text has been revised to be consistent with the language found in section 3.3.3.*

Appendices

Field Sampling Plan

2-2. Table 4-1. Add other parameters to be analyzed such as gross alpha and gross beta, hardness, and total suspended solids.

Response: *Table has been revised to include all containers and parameters.*

Editorial Comments

Section 2.0, page 2-1, paragraph 3, line 3. Change *principle* to “principal.”

Table 2-1, page 2-5, Step 3, bullet 7. It appears that this bullet would be improved by insertion of a comma(s), such as “existing site characterization, groundwater quality sampling and analysis plans and procedures”.

Table 2-1, page 2-6, Step 4, Practical Constraints. Delete the comma and insert a closing parenthesis after *MDS034*.

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Appendices

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Table 4-7, page 4-17, column 10. To be consistent with Table 3-3 in the SAP and Table 4-3 in the FSP, delete *K* and *Na* in the column beginning *Dissolved Ca*.

Response: *The editorial revisions have been made.*



STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

444 Hospital Way #300 • Pocatello, Idaho • 83201

C.L. "Butch" Otter, Governor
Toni Hardesty, Director

15 July 2009

Mr. Barry Koch
Special Projects Lead - Mining
P4 Production, LLC
PO Box 816
Soda Springs, ID 83276-0816

Re: *2009 Groundwater Monitoring Sampling and Analysis Plan, Revision 1*, June 2009

Dear Mr. Koch,

The Agencies and Tribes have reviewed the *2009 Groundwater Monitoring Sampling and Analysis Plan, Revision 1*, June 2009, (*2009 GWSAP*) submitted by P4/Monsanto pursuant to Consent Order/Administrative Order on Consent, EPA Docket No. CERCLA-10-2003-0117 (CO/AOC). This sampling and analysis plan supports continued groundwater data collection at monitoring wells, direct push borehole wells (pre-packs), and strategic seeps and springs for key water quality parameters.

Although the Agencies and Tribes conditionally approved Revision 0 of the *2009 GWSAP* (28 May 09 e-mail from Michael Rowe to Barry Koch), Revision 1 has additional new language regarding groundwater sites to sample in the fall. Thus, final approval will occur after successful resolution of Agency and Tribal comments provided below.

The *2009 Groundwater Monitoring Sampling and Analysis Plan, Revision 1*, June 2009, is considered a deliverable under the CO/AOC, and per Section 9.7 of the CO/AOC, "Within thirty (30) days of P4's receipt of the comment from IDEQ on each draft document, P4 shall amend and submit a revised document to IDEQ that incorporates all comments and corrects all deficiencies identified by IDEQ, unless such comments have been revised or withdrawn in writing." In observance of our review process, I will schedule time on the Monday, 20 July 2009, conference call to answer any questions you might have on the Agency/Tribal comments. Subsequently, the next version of the *2009 Groundwater Monitoring Sampling and Analysis Plan* is due no later than 19 August 2009.

The CO/AOC clearly states that all deliverables shall be submitted in draft form, and are subject to review, comment, and written approval or disapproval by IDEQ. For each

draft document, P4/Monsanto shall amend and submit a revised document to IDEQ that incorporates all comments and corrects all deficiencies. Should P4/Monsanto decide not to comply with the comments provided by IDEQ on behalf of all the Agencies and Tribes, discussions to resolve those issues should be initiated. However, after the Agencies and Tribes have reviewed P4/Monsanto's position and issued instructions to P4/Monsanto to incorporate the original comments, P4/Monsanto must comply or initiate dispute resolution. Future deliverables will be deemed deficient and disapproved should P4/Monsanto fail to comply with the CO/AOC regarding incorporation of Agency/Tribal comments and stipulated penalties may be initiated from the date the revised deliverable was due.

Please let me know if you have any questions. I can be reached at 208-236-6160 or electronically at michael.rowe@deq.idaho.gov.

Sincerely,



Mike Rowe
Regional Mining Project Manager

Enclosure

cc: Robert Geddes (P4/Monsanto)
Cary Foulk (MWH)
Doug Tanner, Bruce Olenick (IDEQ)
Jeff Jones, Mary Kauffman (C-TNF)
Jason Sturm (BLM)
Allen Ruberry (IDL)
Kelly Wright (Shoshone-Bannock Tribes)
Sandi Arena (USFWS)
Dave Tomten (EPA)
Bill Wiley (BIA)
File copy/Monsanto/Correspondence

Agencies and Tribes Comments on
2009 Groundwater Monitoring Sampling and Analysis Plan,
Revision 1, June 2009
15 July 2009

General Comments

1-A. All major changes between revisions of the document should be underlined to assist in Agency/Tribal review.

Specific Comments

(EPA) 0-1. Table 2-1, page 2-5, DQO Step 4. The description for the “Temporal boundary” should be revised to be consistent with the following comment on Section 3.3.3 and Table 3-4 (see below).

(IDEQ) 0-2. Table 3-3, page 3-10. Monitoring wells drilled in 2009 will be part of a summer/fall sampling event and do not need to be sampled for the expanded list of analytes. Sampling for the expanded list of analytes for wells drilled in 2009 should be done in Spring 2010.

(IDEQ) 0-3. Section 3.3.3, page 3-13, and Table 3-4, pages 3-15 and 3-16. Based on increases in both selenium and sulfate, P4/Monsanto has recommended the following wells or surface-expressions-of-groundwater (seeps, springs, headwater streams; SEGW) be sampled as part of a fall event.

- MDS030
- MMW021
- MSG004
- MSG006
- MST069

The Agencies and Tribes are of the opinion that there is no need to sample MMW021 or MSG006. The increase in selenium at MMW021 was only 0.005 mg/L (0.049 to 0.0495 mg/L) from spring to fall in 2008. For the same time period sulfate appeared to increase only 0.6 mg/L (1.3%) from 44.6 to 45.2 mg/L. Although both selenium and sulfate were higher in the fall, we do not think the increases justify fall sampling at MMW021. While in 2004 MSG006 saw increases in selenium and sulfate from spring to fall, concentrations of selenium and sulfate decreased from spring to fall in both 2007 and 2008. Thus, we feel there is little, if anything, to gain by sampling MSG006 in both the spring and fall.

We recommend that the basis to select 2009 fall groundwater sample locations be expanded to include regulatory criteria (selenium primary constituent standard and sulfate secondary constituent standard), a lack of historical fall sample data, and rising trends in concentration as criteria for deciding if 2009 fall sampling should occur at a given

location. Based on these criteria, we recommend that the following 9 groundwater monitoring locations be sampled in Fall 2009, if not dry (e.g., MDS025, MDS034, and MST144).

- 1) Past samples that appear substantially higher in fall than spring and exceed selenium criterion and/or sulfate criterion
 - a) MDS026
 - b) MDS030
 - c) MMW010
 - d) MMW013
 - e) MST069
- 2) Fall samples have never been collected and available spring samples exceed selenium criterion and/or sulfate criterion
 - a) MDS025
 - b) MDS034
 - c) MST144
- 3) Other potential SEGW that appear substantially higher in fall than spring but are below criterion
 - a) MSG004

Based on results from future monitoring events, other wells or SEGW may be added to the list of sites to be sampled in the fall. For example, only data from Fall 2008 are available for MMW027 and MMW029 when concentrations of selenium at these two wells were well above the groundwater quality criterion (0.3140 and 0.8060 mg/L, respectively). Should selenium concentration data from Spring 2009 be substantially lower than the Fall 2008 data, it would make sense to add these two wells to the list of sites for fall monitoring. Another example is MST136. If at some point spring concentrations of selenium exceed the groundwater quality criterion, it should be considered for fall sampling as a SEGW in those years when it is not dry in the fall.

(IDEQ) 0-4. Table 3-4, page 3-14. Please indicate the units (mg/L (?)) for the maximum concentrations presented in the table.

Editorial Comments

Table 2-1, page 2-7, footnote. 2 should be a superscript.

Table 3-2, page 3-7, footnote 2, line 3. Change *were* to "where."

Appendices

Appendix A (Field Sampling Plan), Section 4.2.2, page 4-2, paragraph 6, line 2. Change *ml* to "mL."

**Response to 15 July 2009 Agencies and Tribes Comments on the 2009 Groundwater
Water Monitoring Sampling and Analysis Plan, Revision 1, 09 June 2009**

General Comments

I-A. All major changes between revisions of the document should be underlined to assist in Agency/Tribal review.

Response: *Comment noted. All major changes between Revision 1 and Revision 2 of the document are underlined to assist A/T review. Underlining associated with the previous revision has been removed.*

Specific Comments

(EPA) 0-1. Table 2-1, page 2-5, DQO Step 4. The description for the "Temporal boundary" should be revised to be consistent with the following comment on Section 3.3.3 and Table 3-4 (see below).

Response: *Table 2-1, page 2-5, DQO Step 4 has been revised to be consistent with Section 3.3.3.*

(IDEQ) 0-2. Table 3-3, page 3-10. Monitoring wells drilled in 2009 will be part of a summer/fall sampling event and do not need to be sampled for the expanded list of analytes. Sampling for the expanded list of analytes for wells drilled in 2009 should be done in Spring 2010.

Response: *Monitoring wells installed in fall 2009 will be sampled following development in fall 2009 for the regular list of analytes as are required for the direct push boreholes. We also understand and agree that the 2009 wells will be sampled in the spring 2010 for the expanded analyte list.*

(IDEQ) 0-3. Section 3.3.3, page 3-13, and Table 3-4, pages 3-15 and 3-16. Based on increases in both selenium and sulfate, P4/Monsanto has recommended the following wells or surface-expressions-of-groundwater (seeps, springs, headwater streams; SEGW) be sampled as part of a fall event.

- MDS030
- MMW021
- MSG004
- MSG006
- MST069

The Agencies and Tribes are of the opinion that there is no need to sample MMW021 or MSG006. The increase in selenium at MMW021 was only 0.005 mg/L (0.049 to 0.0495 mg/L) from spring to fall in 2008. For the same time period sulfate appeared to increase only 0.6 mg/L (1.3%) from 44.6 to 45.2 mg/L. Although both selenium and sulfate were higher in

the fall, we do not think the increases justify fall sampling at MMW021. While in 2004 MSG006 saw increases in selenium and sulfate from spring to fall, concentrations of selenium and sulfate decreased from spring to fall in both 2007 and 2008. Thus, we feel there is little, if anything, to gain by sampling MSG006 in both the spring and fall.

We recommend that the basis to select 2009 fall groundwater sample locations be expanded to include regulatory criteria (selenium primary constituent standard and sulfate secondary constituent standard), a lack of historical fall sample data, and rising trends in concentration as criteria for deciding if 2009 fall sampling should occur at a given location. Based on these criteria, we recommend that the following 9 groundwater monitoring locations be sampled in Fall 2009, if not dry (e.g., MDS025, MDS034, and MST144).

1) Past samples that appear substantially higher in fall than spring and exceed selenium criterion and/or sulfate criterion

- a) MDS026
- b) MDS030
- c) MMW010
- d) MMW013
- e) MST069

2) Fall samples have never been collected and available spring samples exceed selenium criterion and/or sulfate criterion

- a) MDS025
- b) MDS034
- c) MST144

3) Other potential SEGW that appear substantially higher in fall than spring but are below criterion

- a) MSG004

Based on results from future monitoring events, other wells or SEGW may be added to the list of sites to be sampled in the fall. For example, only data from Fall 2008 are available for MMW027 and MMW029 when concentrations of selenium at these two wells were well above the groundwater quality criterion (0.3140 and 0.8060 mg/L, respectively). Should selenium concentration data from Spring 2009 be substantially lower than the Fall 2008 data, it would make sense to add these two wells to the list of sites for fall monitoring. Another example is MST136. If at some point spring concentrations of selenium exceed the groundwater quality criterion, it should be considered for fall sampling as a SEGW in those years when it is not dry in the fall.

Response: We agree with IDEQ's rationale to remove MMW021 and MSG006 from the fall sampling event. In addition, we have added MDS025, MDS026, MDS034 MMW010, MMW013, and MST144 to the fall 2009 sampling list that already includes MDS030, MST069, and MSG004. Section 3.3.3 and Table 3-4 have been revised to be consistent with the fall sampling rationale outlined in the comment above. In addition, this section was revised to include a discussion of including wells MMW027 and MMW029 based on spring

2009 sampling results and the inclusion of other stations in future monitoring events based upon potential future exceedances of the groundwater quality criteria.

(IDEQ) 0-4. Table 3-4, page 3-14. Please indicate the units (mg/L (?)) for the maximum concentrations presented in the table.

Response: *The units for the maximum concentrations are stated in the notes on the bottom of Table 3-4. As stated in the notes, concentrations are in mg/L.*

Editorial Comments

Table 2-1, page 2-7, footnote. 2 should be a superscript.

Table 3-2, page 3-7, footnote 2, line 3. Change *were* to "where."

Appendices

Appendix A (Field Sampling Plan), Section 4.2.2, page 4-2, paragraph 6, line 2. Change *ml* to 'mL.'

Response: *The editorial revisions have been made.*



STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

444 Hospital Way, #300 • Pocatello, Idaho 83201 • (208) 236-6160

C.L. "Butch" Otter, Governor
Toni Hardesty, Director

21 May 2009

Mr. Barry Koch
Special Projects Lead - Mining
P4 Production, LLC
PO Box 816
Soda Springs, ID 83276-0816

Re: *2009 Groundwater Monitoring Sampling and Analysis Plan, Revision 0*, May 2009

Dear Mr. Koch,

The Agencies and Tribes have reviewed the *2009 Groundwater Monitoring Sampling and Analysis Plan, Revision 0*, May 2009, (*2009 GWSAP*) submitted by P4/Monsanto pursuant to Consent Order/Administrative Order on Consent, EPA Docket No. CERCLA-10-2003-0117 (CO/AOC). This sampling and analysis plan supports continued groundwater data collection at monitoring wells, direct push borehole wells (pre-packs), and strategic seeps and springs for key water quality parameters. Agency/Tribal comments on the *2009 GWSAP* are provided below.

The *2009 Groundwater Monitoring Sampling and Analysis Plan, Revision 0*, May 2009, is considered a deliverable under the CO/AOC, and per Section 9.7 of the CO/AOC, "Within thirty (30) days of P4's receipt of the comment from IDEQ on each draft document, P4 shall amend and submit a revised document to IDEQ that incorporates all comments and corrects all deficiencies identified by IDEQ, unless such comments have been revised or withdrawn in writing." In observance of our review process, I will schedule time on the Monday, 1 June 2009, conference call to answer any questions you might have on the Agency/Tribal comments. Subsequently, the next version of the *2009 Groundwater Monitoring Sampling and Analysis Plan* is due no later than 1 July 2009.

The CO/AOC clearly states that all deliverables shall be submitted in draft form, and are subject to review, comment, and written approval or disapproval by IDEQ. For each draft document, P4/Monsanto shall amend and submit a revised document to IDEQ that incorporates all comments and corrects all deficiencies. Should P4/Monsanto decide not to comply with the comments provided by IDEQ on behalf of all the Agencies and

Tribes, discussions to resolve those issues should be initiated. However, after the Agencies and Tribes have reviewed P4/Monsanto's position and issued instructions to P4/Monsanto to incorporate the original comments, P4/Monsanto must comply or initiate dispute resolution. Future deliverables will be deemed deficient and disapproved should P4/Monsanto fail to comply with the CO/AOC regarding incorporation of Agency/Tribal comments and stipulated penalties may be initiated from the date the revised deliverable was due.

Please let me know if you have any questions. I can be reached at 208-236-6160 or electronically at michael.rowe@deq.idaho.gov.

Sincerely,

A handwritten signature in black ink that reads "Mike Rowe". The signature is fluid and cursive, with the first name "Mike" and last name "Rowe" clearly legible.

Mike Rowe
Regional Mining Project Manager

Enclosure

cc: Robert Geddes (P4/Monsanto)
Cary Foulk (MWH)
Doug Tanner, Bruce Olenick (IDEQ)
Jeff Jones, Mary Kauffman (C-TNF)
Jason Sturm (BLM)
Allen Ruberry (IDL)
Kelly Wright (Shoshone-Bannock Tribes)
Sandi Arena (USFWS)
Dave Tomten (EPA)
Bill Wiley (BIA)
File copy/Monsanto/Correspondence

Agencies and Tribes Comments on
2009 Groundwater Monitoring Sampling and Analysis Plan,
Revision 0, May 2009
21 May 2009

General Comments

0-A. At our 14 April 2009 meeting, we talked about comparing spring vs fall concentrations of COPCs at groundwater sampling sites to evaluate the need for fall sampling similar to what was done for surface water. Please do so.

0-B. The Data Quality Objectives (DQOs) as written infer that the proposed groundwater sampling plan is primarily a monitoring effort for trend continuity to be used in a future Remedial Investigation/Feasibility Study. Revise the DQOs to clarify that since the groundwater investigation, as part of the site characterization, has been conducted in a phased approach, a good portion of the data collected under this plan will be used to determine fate and transport of COPCs and to help constrain the hydrogeological conceptual model for the identification of potential removal or remedial actions. While this language is included later in the document, it should also be reflected in the DQOs.

0-C. Please delete the word “inactive” when referring to the mine sites currently under a CERCLA CO/ AOC.

0-D. In several places in the document the text states that if analytical data indicate a value that is less than or equal to an associated water quality standard or criterion, then no further characterization is warranted. Please change the text to clarify that analytical values equal to an associated criterion are considered a violation of that criterion and as such would warrant further characterization or remediation.

0-E. Remember to underline major changes between revisions of the document.

Specific Comments

0-1. Section 1.0, page 1-1, paragraph 2, sentence 2. Please revise this sentence to reflect the ongoing monitoring outlined in this document is needed to complete the assessment of nature and extent of contamination, including COPCs other than or in addition to selenium. Since the groundwater investigation has been conducted in a phased approach, many of the groundwater monitoring wells are new and sufficient sampling has not been conducted to screen out COPCs.

0-2. Section 2.0, page 2-1, paragraph 5, sentence 2. The text states that “For this groundwater monitoring program, the data are primarily collected for the measurement of analyte levels in groundwater . . .” Please revise the text to clarify that the data are being

collected primarily to characterize potential contamination and potential risk to human health and ecological receptors.

0-3. Table 2-1, Step 2, Principal Study Question #1. Please revise the statement to “Are COPCs in groundwater monitoring wells and surface expressions of groundwater that assist in groundwater characterization elevated above the appropriate screening levels *that may pose a risk to human health or ecological receptors?*”

0-4. Table 2-1, Step 2, Principal Study Question #1. The “alternative actions” under Principal Study Question #1 are expressed only as possible outcomes, not actions. Principal Study Question #1 is a decision problem, so each action should also identify a logical course of action in response to the possible outcome. The course of action should be consistent with actions described in the “decision statement.”

0-5. Table 2-1, Step 2, Principal Study Question #1. In the “decision statement” for Step 2, the intent of the text appears to be to describe the leading edge of the plume. Whereas, the reader may confuse the term “boundary” with a “property boundary,” the text should be revised and the term “boundary” deleted, as appropriate.

0-6. Table 2-1, Step 2, Principal Study Question #1, Decision statement. Please include a footnote referencing the source(s) of the appropriate screening levels or where that information is contained later in the document.

0-7. Table 2-1, Step 2, Principal Study Question #1, Decision statement. The text implies that should COPC concentrations be elevated in relation to background but below relevant water quality criteria then no further characterization is required. Please revise the text to clarify that this may not be the case if the data indicate increasing trends either temporally or spatially that could warrant further characterization (e.g., fate and transport).

0-8. Table 2-1, Step 2, Principal Study Question #2. As worded, it appears the data objective for continued sampling of the surface expressions of groundwater is to see if they are being adequately monitored. In other words, this data objective appears to be to monitor for the sake of monitoring. Please revise this section to reflect that since P4/Monsanto proposed to conduct the groundwater investigation in phases, and as new wells were added as recently as last fall and have yet to be sampled, continued monitoring of the surface expressions of groundwater is necessary to further constrain the hydrogeologic conceptual model and to help constrain the nature and extent of contamination.

0-9. Table 2-1, Step 2, Principal Study Question #3. Please revise the text to reflect that coincident sampling of surface water and groundwater is being conducted to identify potential interconnected systems that will aid in evaluation of fate and transport of COPCs and perhaps aid in targeting pathways for removal or remedial actions.

0-10. Table 2-1, Step 2, Principal Study Question #3. The “action” under Principal Study Question #3 appears to be incomplete. Given that the No Action alternative is based on the outcome that “. . . station data and analyte lists are of adequate quality, quantity, and in proper locations to determine the relationship (if any) between temporal changes in groundwater and surface water quality . . .”, then the “action” alternative should indicate what action will be taken if the outcome is not of adequate quality, quantity, and in proper locations to determine the relationship (if any) between temporal changes in groundwater and surface water quality. Revise the “action” alternative to identify a logical course of action in response to the particular outcome, consistent with the course of action described in the “decision statement.”

0-11. Table 2-1, Step 4, page 2-5. For clarification, the description for the “spatial boundaries” should be revised to include “surface water expressions of groundwater” as follows: “Groundwater monitoring locations, including surface water expressions of groundwater, characterizing impacted groundwater at Ballard, Henry, and Enoch Valley mine areas.”

0-12. Table 2-1, Step 5, Principal Study Question #1. The parenthetical insertion “(where groundwater contributions are responsible for elevating surface water concentrations)” is unnecessary and should be deleted because this phrase, as stated, inaccurately limits the applicability of selenium cold water criteria of 0.005 mg/L to situations “where groundwater contributions are responsible for elevating surface water concentrations.”

0-13. Table 2-1, Step 5, Principal Study Question #1. The text states “Other COPCs will be evaluated, but for groundwater, selenium has been found to be the best indicator of impacts associated with mine waste areas.” Please revise the text to clarify that in general, selenium appears to be the driving COPC for the Ballard, Henry, and Enoch Valley Mines. There are other phosphate mine sites in the Blackfoot River watershed where other COPCs such as cadmium are the driver rather than selenium.

0-14. Table 2-1, Step 5, Principal Study Questions #2 and #3. Principal Study Questions #2 and #3 specifically identify temporal trends in groundwater and surface water as the focus of the study; however, the role of temporal trends is not included in the Analytical Approach of Step 5. The Analytical Approach for Principal Study Questions #2 and #3 should address how temporal trends may affect the analytical approach and decisions under Step 5.

0-15. Table 2-1, Step 6. The text states that “Analytical parameters will be compared to the applicable groundwater quality risk-based screening level.” Please reference the appropriate sources identified later in this document through use of a footnote.

0-16. Table 2-1, Step 7. It is stated that “The sampling design will be further evaluated if groundwater quality monitoring suggests that the proposed locations and analytes are not sufficient to assist in groundwater characterization of the shallow aquifers.” Would this not hold true for the medium (i.e., Dinwoody Fm) and deep (i.e., Wells Fm) aquifers, too? If not, why not? If so, please revise accordingly.

0-17. Section 3.2, page 3-2, bullet 2. In the referenced letter, aluminum and iron were included in the list of unfiltered analytes to sample for groundwater. Please add Al and Fe to this list.

0-18. Section 3.2.1, page 3-4. MMW009 must continue to be sampled for the parameters identified in the 16 September 2008 letter to P4/Monsanto regarding analytes for sampling in 2008. The requisite analytes were selected based upon past data and the fact mining at the Enoch Valley Mine was completed relatively recently and has not, in all probability, reached geochemical equilibrium, nor has enough time passed to definitively determine completed transport pathways.

0-19. Table 3-2. In its current form, the Table implies that each analyte has been sampled at each sample location listed in Table 3-2. If this is the case, then the text and table should specify that each analyte has been sampled at least once at each location; therefore, a blank cell should be noted accordingly. If, however, a specific analyte has not yet been sampled at a specific location, then the corresponding cell in the Table should clearly specify that the analyte has not been sampled at that location.

0-20. Table 3-2, page 3-7, footnote 1. Four locations are mentioned, but only two stations (MMW004 and MPW022) are footnoted. Please reconcile.

0-21. Section 3.3.1, page 3-8. The text discusses agricultural, domestic, and borehole monitoring wells, but these locations are not included on Table 3-2, as were the other groundwater sampling locations identified in Section 3.3.1 (that is, the production and monitoring wells, springs, and seeps are included in Table 3-2 but not the agricultural, domestic, and borehole monitoring wells). Revise the Table to include these locations or provide appropriate text explaining why they are not included in the Table.

0-22. Section 3.3.1. The following two monitoring wells appear to be strategically located within plumes on the west side of the Ballard Mine and should be added to the 2009 groundwater monitoring plan. Both wells should be sampled for the expanded list of analytes, consistent with the other project monitoring wells.

- MW-15A. MW-15A should be included in the monitoring program because MW-15A is located at the toe of a potential source (MWD080), is highly contaminated with selenium, and there is only one other alluvial sample location (MBW028) in the area.
- MW-16A. MW-16A should be included in the monitoring program because MW-16A was elevated in selenium in 2008 and is downgradient of monitoring well MMW030 which was nondetect for selenium in fall 2008.

The following three stream locations should be included in the 2009 groundwater monitoring plan, assuming they are flowing and are confirmed to be representative of surface water expressions of groundwater potentially impacted by P4/Monsanto mine activities. Note that these locations are not included in the 2009 and 2010 surface water

monitoring program, so are not redundant of surface water sampling efforts. These locations should be sampled for the list of analytes for springs and seeps.

- MST096, Ballard Mine. This monitoring location should be included because it currently represents the easternmost monitoring point for the southeast plume at MWD082 as portrayed on Drawing 27 of the *2007 & 2008 Data Summary Report — Draft* (MWH, March 2009).
- MST136 and MST144, Enoch Valley Mine. These monitoring locations should be included because both streams go dry in the fall suggesting they are potential expressions of groundwater, may represent groundwater monitoring points for the impacts from MWD092, are elevated in selenium, and the nearby 2008 direct push borehole samples did not exhibit detectable selenium.

0-23. Section 3.3.1, page 3-8, paragraph 4. It is stated that P4/Monsanto believes that water at MSG008 and MST069 is from the same source. Please provide necessary data to support this assertion.

0-24. Section 3.3.1, page 3-8, paragraph 4. It is proposed that MST069 be sampled as both a surface water and groundwater station. P4/Monsanto must recognize that the suite of analytes may differ for surface water and groundwater at MST069. In addition, the dissolved fraction is of most concern for surface water stations whereas the total fraction is more important at groundwater stations. This concern may be resolved in Section 3.3.2 where P4/Monsanto recommends that only unfiltered or total fractions be analyzed. Please indicate that MST069 will be sampled for both groundwater and surface water, which will require analysis of different suites of analytes and different fractions of those analytes.

0-25. Section 3.3.2, page 3-8, paragraph 6. This paragraph currently indicates that only unfiltered fractions will be analyzed. Revise the paragraph to be consistent with the list of filtered and unfiltered analytes identified in Table 3-3.

0-26. Section 3.3.2, page 3-8. The A/T recommend the analyte list for the new wells anticipated to be drilled in the fall of 2009 be included in this section.

0-27. Table 3-3, page 3-10, row 1 (2008 monitoring wells), column 3. Add unfiltered Fe to the list of analytes to sample. Note that iron is listed in Table B-3 (page 3-12) and has a secondary constituent standard for groundwater.

0-28. Table 3-3, page 3-10, row 2 (Direct push borehole wells), column 3. Add unfiltered Cr and Fe to the list of analytes to sample per the 16 September 2008 letter from Mike Rowe to Barry Koch.

0-29. Table 3-3, page 3-10, row 4 (Seeps and springs), column 3. According to Table 3-2, total dissolved solids were high for many seeps and springs. Yet, P4/Monsanto does

not propose to sample for it. Please provide rationale for not sampling TDS, which has a secondary constituent standard for groundwater.

Appendices

Field Sampling Plan

0-30. Tables 4-3, 4-4, 4-5, and 4-7, pages 4-8, 4-11, 4-12, and 4-16. Please revise these tables based on A/T's previous comments on Table 3-3 – unfiltered Fe in 2008 monitoring wells, unfiltered Cr and Fe in direct push borehole wells, and possibly TDS in seeps and springs.

Editorial Comments

Section 2.0, page 2-1, paragraph 1, line 5. The ending parenthesis should be outside the period.

Section 2.0, page 2-2, bullet 1, line 1. Capitalize *constituents*.

Section 2.0, page 2-2, bullet 1, line 3. Change *is* to “are.”

Section 2.0, page 2-2, bullet 3, line 1. Delete *and*.

Table 2-1, Step 1, paragraph 1, line 1. Change *P4s* to “P4’s.”

Table 2-1, Step 1, bullet 1, line 1. Put a space between the hyphen and *COPCs*.

Table 2-1, Step 1, bullet 3, line 1. Delete *and*.

Table 2-1, Step 4, Temporal boundary, line 5. Insert “be” between *will* and *monitored*.

Section 3.2, page 3-2, bullet 4. Add a space between the comma and *thallium*.

Section 3.2.1, page 3-3, line 1. Insert “*Parameters*” after *Groundwater*.

Section 3.2.1, page 3-3, paragraph 2, line 5. Add a comma after *or in lieu of*.

Table 3-2, page 3-7, footnote 2, line 3. Change *were* to “where.”

Table 3-2, page 3-7, footnote R. Change *Well* to “Wells.”

Section 3.3.1, page 3-8, paragraph 2, line 1. Change *reason* to “reasons.”

Table 3-3, page 3-10, row 1 (2008 monitoring wells), column 3. Change *Th* to “Tl.”

Appendix A, Field Sampling Plan

Section 2.0, page 2-1, paragraph 2, line 8. Change *complimentary* to “complementary.”

Section 4.1, page 4-1, paragraph 2, line 6. Eliminate the first *contacts*, after the word *agency*.

Section 4.1, page 4-1, paragraph 4, line 7. Add a comma after *i.e.*

Section 4.2.2., page 4-2, paragraph 6, line 2. Delete the period after *feet*.

Section 4.7, page 4-7, bullet 8. Delete the space between the first parentheses and *blank*.

Section 4.7, page 4-7, paragraph 2, line 1. Shouldn't it be **0905-MMW020-GW-F-1** rather than **0905-MMW020-GW-I-F**?

Section 4.10, page 4-10, bullet 2. *Distilled water* should be deionized water as in bullet 1.

Response to 21 May 2009 Agencies and Tribes Comments on the 2009 Groundwater Water Monitoring Sampling and Analysis Plan, Revision 0, 06 May 2009

General Comments

0-A. At our 14 April 2009 meeting, we talked about comparing spring vs fall concentrations of COPCs at groundwater sampling sites to evaluate the need for fall sampling similar to what was done for surface water. Please do so.

Response: Section 3.3.3, Seasonal Sampling Evaluation, and Table 3-4, Summary of Selenium and Sulfate Concentrations and Seasonal Sampling Evaluation, have been add to the SAP in order evaluate and list stations that will be sampled in the spring and fall 2009.

0-B. The Data Quality Objectives (DQOs) as written infer that the proposed groundwater sampling plan is primarily a monitoring effort for trend continuity to be used in a future Remedial Investigation/Feasibility Study. Revise the DQOs to clarify that since the groundwater investigation, as part of the site characterization, has been conducted in a phased approach, a good portion of the data collected under this plan will be used to determine fate and transport of COPCs and to help constrain the hydrogeological conceptual model for the identification of potential removal or remedial actions. While this language is included later in the document, it should also be reflected in the DQOs.

Response: Table 2-1, Step 1 states “Continued monitoring is needed to assist in determination of the nature and extent of selenium impacts in groundwater. In addition, the groundwater monitoring provides beneficial information regarding groundwater/surface water interaction, which will assist in refinement of the hydrogeologic conceptual models of the Sites.” Although this section is not worded exactly the same as the comment, we believe that it states similar objectives. However, the section has been revised to make it more consistent with the A/T comment and include other potential COPC impacts as well as include the identification of potential removal or remedial actions.

0-C. Please delete the word “inactive” when referring to the mine sites currently under a CERCLA CO/ AOC.

Response: This word only appeared once in the SAP introduction in order to refer to the inactive P4 properties, collectively referred to as the Sites, as was approved in the 2009 and 2010 Surface Water Monitoring Plan (MWH, 2009). However, the word “inactive” has been removed from the first paragraph in Section 1.0 to address this comment.

0-D. In several places in the document the text states that if analytical data indicate a value that is less than or equal to an associated water quality standard or criterion, then no further characterization is warranted. Please change the text to clarify that analytical values equal to an associated criterion are considered a violation of that criterion and as such would warrant further characterization or remediation.

Response: There were only two uses of this scenario as they applied to principal study question #1 in Table 2-1. In addition, IDAPA 58.01.11 200. Groundwater Quality Standards, states that the “following numerical and narrative standards apply to all ground water of the state and shall not be exceeded unless otherwise allowed in this rule”. The rules do not address a value equal to the criterion as a violation of this criterion. However, P4 has revised the decision rules for principal study question #1 to address this comment.

0-E. Remember to underline major changes between revisions of the document.

Response: Agreed, significant changes in the revised documents have been underlined.

Specific Comments

0-1. Section 1.0, page 1-1, paragraph 2, sentence 2. Please revise this sentence to reflect the ongoing monitoring outlined in this document is needed to complete the assessment of nature and extent of contamination, including COPCs other than or in addition to selenium. Since the groundwater investigation has been conducted in a phased approach, many of the groundwater monitoring wells are new and sufficient sampling has not been conducted to screen out COPCs.

Response: Section 1.0, page 1-1, paragraph 2, sentence 2 has been revised to include COPCs other than selenium.

0-2. Section 2.0, page 2-1, paragraph 5, sentence 2. The text states that “For this groundwater monitoring program, the data are primarily collected for the measurement of analyte levels in groundwater . . .” Please revise the text to clarify that the data are being collected primarily to characterize potential contamination and potential risk to human health and ecological receptors.

Response: Section 2.0, page 2-1, paragraph 5, sentence 2 has been revised to state “For this groundwater monitoring program, the data are primarily collected for the measurement of analyte levels in groundwater to characterize potential contamination and potential risk to human health and ecological receptors...”

0-3. Table 2-1, Step 2, Principal Study Question #1. Please revise the statement to “Are COPCs in groundwater monitoring wells and surface expressions of groundwater that assist in groundwater characterization elevated above the appropriate screening levels that may pose a risk to human health or ecological receptors?”

Response: Table 2-1, Step 2, Principal Study Question #1 has been revised to state “Are COPCs in groundwater monitoring wells and surface expressions of groundwater that assist in groundwater characterization elevated above the appropriate screening levels¹ that may pose a risk to human health or ecological receptors?”

0-4. Table 2-1, Step 2, Principal Study Question #1. The “alternative actions” under Principal Study Question #1 are expressed only as possible outcomes, not actions. Principal Study Question #1 is a decision problem, so each action should also identify a logical course of action in response to the possible outcome. The course of action should be consistent with actions described in the “decision statement.”

Response: Table 2-1, Step 2, Principal Study Question #1. The alternative actions have been revised to address this comment.

0-5. Table 2-1, Step 2, Principal Study Question #1. In the “decision statement” for Step 2, the intent of the text appears to be to describe the leading edge of the plume. Whereas, the reader may confuse the term “boundary” with a “property boundary,” the text should be revised and the term “boundary” deleted, as appropriate.

Response: Table 2-1, Step 2, Principal Study Question #1 has been revised to remove the term “boundary” and refer to the “edge of the plume.”

0-6. Table 2-1, Step 2, Principal Study Question #1, Decision statement. Please include a footnote referencing the source(s) of the appropriate screening levels or where that information is contained later in the document.

Response: Table 2-1, Step 2, Principal Study Question #1. The decision statement has been revised to include a footnote referencing Table 3-1, Achievable Laboratory Limits and Applicable Project Screening Values Groundwater Parameters.

0-7. Table 2-1, Step 2, Principal Study Question #1, Decision statement. The text implies that should COPC concentrations be elevated in relation to background but below relevant water quality criteria then no further characterization is required. Please revise the text to clarify that this may not be the case if the data indicate increasing trends either

¹ Table 3-1, *Achievable Laboratory Limits and Applicable Project Screening Values Groundwater Parameters*, contains the applicable risk-based screening levels.

temporally or spatially that could warrant further characterization (e.g., fate and transport).

Response: Table 2-1, Step 2, Principal Study Question #1. The decision statement has been revised to address this comment.

0-8. Table 2-1, Step 2, Principal Study Question #2. As worded, it appears the data objective for continued sampling of the surface expressions of groundwater is to see if they are being adequately monitored. In other words, this data objective appears to be to monitor for the sake of monitoring. Please revise this section to reflect that since P4/Monsanto proposed to conduct the groundwater investigation in phases, and as new wells were added as recently as last fall and have yet to be sampled, continued monitoring of the surface expressions of groundwater is necessary to further constrain the hydrogeologic conceptual model and to help constrain the nature and extent of contamination.

Response: Table 2-1, Step 2, Principal Study Question #2 has been revised to address this comment.

0-9. Table 2-1, Step 2, Principal Study Question #3. Please revise the text to reflect that coincident sampling of surface water and groundwater is being conducted to identify potential interconnected systems that will aid in evaluation of fate and transport of COPCs and perhaps aid in targeting pathways for removal or remedial actions.

Response: Table 2-1, Step 2, Principal Study Question #3 has been revised to address this comment.

0-10. Table 2-1, Step 2, Principal Study Question #3. The “action” under Principal Study Question #3 appears to be incomplete. Given that the No Action alternative is based on the outcome that “. . . station data and analyte lists are of adequate quality, quantity, and in proper locations to determine the relationship (if any) between temporal changes in groundwater and surface water quality . . .”, then the “action” alternative should indicate what action will be taken if the outcome is not of adequate quality, quantity, and in proper locations to determine the relationship (if any) between temporal changes in groundwater and surface water quality. Revise the “action” alternative to identify a logical course of action in response to the particular outcome, consistent with the course of action described in the “decision statement.”

Response: Table 2-1, Step 2, Principal Study Question #3. The action alternatives have been revised to include an outcome consistent with the decision statement.

0-11. Table 2-1, Step 4, page 2-5. For clarification, the description for the “spatial boundaries” should be revised to include “surface water expressions of groundwater” as follows: “Groundwater monitoring locations, including surface water expressions of groundwater, characterizing impacted groundwater at Ballard, Henry, and Enoch Valley mine areas.”

Response: *Table 2-1, Step 4 has been revised to include this language.*

0-12. Table 2-1, Step 5, Principal Study Question #1. The parenthetical insertion “(where groundwater contributions are responsible for elevating surface water concentrations)” is unnecessary and should be deleted because this phrase, as stated, inaccurately limits the applicability of selenium cold water criteria of 0.005 mg/L to situations “where groundwater contributions are responsible for elevating surface water concentrations.”

Response: *Table 2-1, Step 5, Principal Study Question #1 has been revised to remove the parenthetical insertion.*

0-13. Table 2-1, Step 5, Principal Study Question #1. The text states “Other COPCs will be evaluated, but for groundwater, selenium has been found to be the best indicator of impacts associated with mine waste areas.” Please revise the text to clarify that in general, selenium appears to be the driving COPC for the Ballard, Henry, and Enoch Valley Mines. There are other phosphate mine sites in the Blackfoot River watershed where other COPCs such as cadmium are the driver rather than selenium.

Response: *Table 2-1, Step 5, Principal Study Question #1 has been revised to state “Other COPCs will be evaluated, but for groundwater at P4’s sites, selenium has been found to be the best indicator of impacts associated with mine waste areas.”*

0-14. Table 2-1, Step 5, Principal Study Questions #2 and #3. Principal Study Questions #2 and #3 specifically identify temporal trends in groundwater and surface water as the focus of the study; however, the role of temporal trends is not included in the Analytical Approach of Step 5. The Analytical Approach for Principal Study Questions #2 and #3 should address how temporal trends may affect the analytical approach and decisions under Step 5.

Response: *Table 2-1, Step 5, Principal Study Questions #2 and #3 have been revised to discuss how temporal trends may affect the analytical approach and decisions.*

0-15. Table 2-1, Step 6. The text states that “Analytical parameters will be compared to the applicable groundwater quality risk-based screening level.” Please reference the appropriate sources identified later in this document through use of a footnote.

Response: *Table 2-1, Step 6 has been revised to include a footnote referencing Table 3-1, Achievable Laboratory Limits and Applicable Project Screening Values Groundwater Parameters.*

0-16. Table 2-1, Step 7. It is stated that “The sampling design will be further evaluated if groundwater quality monitoring suggests that the proposed locations and analytes are not sufficient to assist in groundwater characterization of the shallow aquifers.” Would this not hold true for the medium (i.e., Dinwoody Fm) and deep (i.e., Wells Fm) aquifers, too? If not, why not? If so, please revise accordingly.

Response: *Table 2-1, Step 7 has been revised to remove the reference to “shallow aquifers” and make the statement more general to address site-wide groundwater.*

0-17. Section 3.2, page 3-2, bullet 2. In the referenced letter, aluminum and iron were included in the list of unfiltered analytes to sample for groundwater. Please add Al and Fe to this list.

Response: *Aluminum and iron have been added to Section 3.2, page 3-2, bullet 2.*

0-18. Section 3.2.1, page 3-4. MMW009 must continue to be sampled for the parameters identified in the 16 September 2008 letter to P4/Monsanto regarding analytes for sampling in 2008. The requisite analytes were selected based upon past data and the fact mining at the Enoch Valley Mine was completed relatively recently and has not, in all probability, reached geochemical equilibrium, nor has enough time passed to definitively determine completed transport pathways.

Response: *It is proposed that MMW009 be analyzed for the expanded list of analytes similar to the 2008 and 2009 monitoring wells. This list is a more exhaustive list compared to the parameters identified in the 16 September 2008 letter to P4/Monsanto. Section 3.0 of the SAP as well as the FSP have been revised to reflect this change.*

0-19. Table 3-2. In its current form, the Table implies that each analyte has been sampled at each sample location listed in Table 3-2. If this is the case, then the text and table should specify that each analyte has been sampled at least once at each location; therefore, a blank cell should be noted accordingly. If, however, a specific analyte has not yet been sampled at a specific location, then the corresponding cell in the Table should clearly specify that the analyte has not been sampled at that location.

Response: *Table 3-2 has been revised to identify whether a specific analyte has or has not been sampled at a specific location.*

0-20. Table 3-2, page 3-7, footnote 1. Four locations are mentioned, but only two stations (MMW004 and MPW022) are footnoted. Please reconcile.

Response: *Table 3-2, page 3-7, footnote 1 has been changed to address this comment.*

0-21. Section 3.3.1, page 3-8. The text discusses agricultural, domestic, and borehole monitoring wells, but these locations are not included on Table 3-2, as were the other groundwater sampling locations identified in Section 3.3.1 (that is, the production and monitoring wells, springs, and seeps are included in Table 3-2 but not the agricultural, domestic, and borehole monitoring wells). Revise the Table to include these locations or provide appropriate text explaining why they are not included in the Table.

Response: *Language has been added to the final paragraph of Section 3.2.1 below Table 3-2 to address this comment. Section 3.3.1 refers to location selection and did not seem like an appropriate section to address this comment as it pertains to analytical screening.*

0-22. Section 3.3.1. The following two monitoring wells appear to be strategically located within plumes on the west side of the Ballard Mine and should be added to the 2009 groundwater monitoring plan. Both wells should be sampled for the expanded list of analytes, consistent with the other project monitoring wells.

- MW-15A. MW-15A should be included in the monitoring program because MW-15A is located at the toe of a potential source (MWD080), is highly contaminated with selenium, and there is only one other alluvial sample location (MBW028) in the area.
- MW-16A. MW-16A should be included in the monitoring program because MW-16A was elevated in selenium in 2008 and is downgradient of monitoring well MMW030 which was nondetect for selenium in fall 2008.

The following three stream locations should be included in the 2009 groundwater monitoring plan, assuming they are flowing and are confirmed to be representative of surface water expressions of groundwater potentially impacted by P4/Monsanto mine activities. Note that these locations are not included in the 2009 and 2010 surface water monitoring program, so are not redundant of surface water sampling efforts. These locations should be sampled for the list of analytes for springs and seeps.

- MST096, Ballard Mine. This monitoring location should be included because it currently represents the easternmost monitoring point for the southeast plume at MWD082 as portrayed on Drawing 27 of the *2007 & 2008 Data Summary Report — Draft* (MWH, March 2009).
- MST136 and MST144, Enoch Valley Mine. These monitoring locations should be included because both streams go dry in the fall suggesting they are potential

expressions of groundwater, may represent groundwater monitoring points for the impacts from MWD092, are elevated in selenium, and the nearby 2008 direct push borehole samples did not exhibit detectable selenium.

Response: Section 3.0 of the SAP and the FSP have been revised to include MW-15A and MW-16A with the 2008 and 2009 monitoring wells, which will be sampled for the expanded analyte list. In addition, stream locations MST096, MST136, and MST144 have been added to SAP and FSP. However, we disagree with the statement that because MST136 and MST144 go dry in the fall, that these locations are potential expressions of groundwater. The typical conceptual model is that if a stream location dries up in the summer and fall, then it is likely that the source of the water is from runoff and shallow interflow water. It would be expected that a stream location being recharged by groundwater would report a base flow throughout the year.

0-23. Section 3.3.1, page 3-8, paragraph 4. It is stated that P4/Monsanto believes that water at MSG008 and MST069 is from the same source. Please provide necessary data to support this assertion.

Response: MSG008 exits the ground through a pipe in such a way that it parallels then intersects with MST069 channel. In addition, both locations have similar geochemical concentrations; however, MST069 has higher Se and SO₄ concentrations (approximately a factor of two to three) compared to MSG008. For this reason, MST069 will be sampled under both the surface water and groundwater monitoring programs.

0-24. Section 3.3.1, page 3-8, paragraph 4. It is proposed that MST069 be sampled as both a surface water and groundwater station. P4/Monsanto must recognize that the suite of analytes may differ for surface water and groundwater at MST069. In addition, the dissolved fraction is of most concern for surface water stations whereas the total fraction is more important at groundwater stations. This concern may be resolved in Section 3.3.2 where P4/Monsanto recommends that only unfiltered or total fractions be analyzed. Please indicate that MST069 will be sampled for both groundwater and surface water, which will require analysis of different suites of analytes and different fractions of those analytes.

Response: Section 3.0 of the SAP and the FSP have been revised to include MST069 in both the surface water and groundwater monitoring programs, which requires a different suite of constituents.

0-25. Section 3.3.2, page 3-8, paragraph 6. This paragraph currently indicates that only unfiltered fractions will be analyzed. Revise the paragraph to be consistent with the list of filtered and unfiltered analytes identified in Table 3-3.

Response: *Section 3.3.2, paragraph 6 has been revised to clarify that the unfiltered fractions for metals will be analyzed. As shown on Table 3-3, other analytes will be filtered, as needed.*

0-26. Section 3.3.2, page 3-8. The A/T recommend the analyte list for the new wells anticipated to be drilled in the fall of 2009 be included in this section.

Response: *These wells are included in Section 3.0 and the FSP. Table 3-3 has been revised to include the proposed 2009 wells.*

0-27. Table 3-3, page 3-10, row 1 (2008 monitoring wells), column 3. Add unfiltered Fe to the list of analytes to sample. Note that iron is listed in Table B-3 (page 3-12) and has a secondary constituent standard for groundwater.

Response: *Table 3-3, row 1 (2008 monitoring wells), column 3 has been revised to include unfiltered iron.*

0-28. Table 3-3, page 3-10, row 2 (Direct push borehole wells), column 3. Add unfiltered Cr and Fe to the list of analytes to sample per the 16 September 2008 letter from Mike Rowe to Barry Koch.

Response: *Table 3-3, row 2 (Direct push borehole wells), column 3 has been revised to include unfiltered iron and chromium.*

0-29. Table 3-3, page 3-10, row 4 (Seeps and springs), column 3. According to Table 3-2, total dissolved solids were high for many seeps and springs. Yet, P4/Monsanto does not propose to sample for it. Please provide rationale for not sampling TDS, which has a secondary constituent standard for groundwater.

Response: *TDS was inadvertently left out of this table. Table 3-3 and the FSP have been revised to include TDS for seeps, springs, and streams.*

Appendices

Field Sampling Plan

0-30. Tables 4-3, 4-4, 4-5, and 4-7, pages 4-8, 4-11, 4-12, and 4-16. Please revise these tables based on A/T's previous comments on Table 3-3 – unfiltered Fe in 2008 monitoring wells, unfiltered Cr and Fe in direct push borehole wells, and possibly TDS in seeps and springs.

Response: *The FSP has been revised to address changes to Section 3.0 and Table 3-3 of the SAP.*

Editorial Comments

Section 2.0, page 2-1, paragraph 1, line 5. The ending parenthesis should be outside the period.

Section 2.0, page 2-2, bullet 1, line 1. Capitalize *constituents*.

Section 2.0, page 2-2, bullet 1, line 3. Change *is* to “are.”

Section 2.0, page 2-2, bullet 3, line 1. Delete *and*.

Table 2-1, Step 1, paragraph 1, line 1. Change *P4s* to “P4’s.”

Table 2-1, Step 1, bullet 1, line 1. Put a space between the hyphen and *COPCs*.

Table 2-1, Step 1, bullet 3, line 1. Delete *and*.

Table 2-1, Step 4, Temporal boundary, line 5. Insert “be” between *will* and *monitored*.

Section 3.2, page 3-2, bullet 4. Add a space between the comma and *thallium*.

Section 3.2.1, page 3-3, line 1. Insert “*Parameters*” after *Groundwater*.

Section 3.2.1, page 3-3, paragraph 2, line 5. Add a comma after *or in lieu of*.

Table 3-2, page 3-7, footnote 2, line 3. Change *were* to “where.”

Table 3-2, page 3-7, footnote R. Change *Well* to “Wells.”

Section 3.3.1, page 3-8, paragraph 2, line 1. Change *reason* to “reasons.”

Table 3-3, page 3-10, row 1 (2008 monitoring wells), column 3. Change *Th* to “Tl.”

Appendix A, Field Sampling Plan

Section 2.0, page 2-1, paragraph 2, line 8. Change *complimentary* to “complementary.”

Section 4.1, page 4-1, paragraph 2, line 6. Eliminate the first *contacts*, after the word *agency*.

Section 4.1, page 4-1, paragraph 4, line 7. Add a comma after *i.e.*

Section 4.2.2., page 4-2, paragraph 6, line 2. Delete the period after *feet*.

Section 4.7, page 4-7, bullet 8. Delete the space between the first parentheses and *blank*.

Section 4.7, page 4-7, paragraph 2, line 1. Shouldn’t it be **0905-MMW020-GW-F-1** rather than **0905-MMW020-GW-I-F**?

Section 4.10, page 4-10, bullet 2. *Distilled water* should be deionized water as in bullet 1.

Response: *The editorial revisions have been made.*